1272143

General Property Investigation
Sampling and Analysis Plan/Quality Assurance Project Plan
Libby Asbestos Site, Operable Unit 4
Libby, Montana

Revision 2

April 2013

Contract No. W912F-11-D-0023
Task Order No. 0003

Prepared for:

ENVIRONMENTAL PROTECTION AGENCY
Region VIII

Prepared by:

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A Project Management

A1. Title and Approval Sheet

Title: General Property Investigation Sampling and Analysis Plan/Quality Assurance Project Plan, Libby Asbestos Site, Operable Unit 4. Revision 2, April 2013

Reviewed by: ______________________ Date: 4/15/13
Thomas E. Cook
CDM Smith, Project Manager

Reviewed by: ______________________ Date: 4/15/13
for Terry Crowell
CDM Smith, Quality Assurance Coordinator

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USACE, Project Manager

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Approved by: ______________________ Date: 4/16/13
Elizabeth Fagen, P.E.
EPA Region VIII, Operable Unit 4 Remedial Project Manager

Approved by: ______________________ Date: 4/16/13
Rebecca Thomas
EPA Region VIII, Libby Asbestos Project Team Leader

Approved by: No comment – Date: 2013
Linda Himmelbauer
EPA Region VIII, Quality Assurance Manager

REVISION LOG:

Revision No.	Date	Description
0	4/23/2010	---
1	4/16/2012	• Made editorial changes, corrected typographical errors • Sample ID prefix change from 2S- / 2D- to 3G- • Bulk samples will no longer be collected or analyzed • Screening Investigation no longer requires a land survey
2	4/15/2013	• Made editorial changes, corrected typographical errors • Changed document format and included EPA Region 8 Quality Assurance Document Review Crosswalk • Updated distribution list • Added section for project/task organization • Added project organizational chart • Added Troy sample preparation facility procedures • Updated data validation and usability section • Updated references • Eliminated Exterior Property Information Form • Sample ID prefix change from 3G- to 4G- • Areas with vermiculite may be sampled at DI at the direction of USACE or EPA • Incorporated Flowerpot Memo

A2. Table of Contents

List of Tables

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List of Acronyms and Abbreviations

%	percent
A&E	architectural and engineering contractor
AHERA	Asbestos Hazard Emergency Response Act
APP	Accident Prevention Plan
AS	analytical sensitivity
ASTM	American Society for Testing and Materials
CB&I	CB&I Federal Services
CDM Smith	CDM Federal Programs Corporation
COC	chain-of-custody
CFR	Code of Federal Regulations
CSS	Contaminant Screening Study
CUA	common-use area
DEQ	Montana Department of Environmental Quality
DI	detailed investigation
DQOs	data quality objectives
EDD	electronic data deliverable
EDS	energy dispersive spectroscopy
EPA	U.S. Environmental Protection Agency
ERS	Environmental Resource Specialist
ERT	EPA Environmental Response Team
ESAT	EPA Environmental Services Assistance Team
f/cc	fiber per cubic centimeter
FPM	field planning meeting
FSDS	field sample data sheet
FTL	field team leader
GIS	geographic information system
GPI	general property investigation
GPS	global positioning system
H&S	health and safety
HAZWOPER	Hazardous Waste Operations and Emergency Response
HVAC	heating, ventilation, and air conditioning
ID	identifier
IDW	investigation-derived waste
IFF	Information Field Form
IPIF	Interior Property Inspection Form
LA	Libby Amphibole asbestos
LADT	Libby Asbestos Data Tool
LC	laboratory coordinator
LUA	limited-use area
N	number
NA	not applicable
ND	none detected
NIST	National Institute of Standards and Technology
NUA	non-use area
NVLAP	National Voluntary Laboratory Accreditation Program

OIF	Occupant Information Form
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCM	phase contrast microscopy
PE	performance evaluation
PLM	polarized light microscopy
PLM-Grav	polarized light microscopy – gravimetric
PLM-VE	polarized light microscopy – visual estimation
POC	property operations coordinator
PPE	personal protective equipment
QA	quality assurance
QAM	quality assurance manager
QAPP	quality assurance project plan
QATS	Quality Assurance Technical Support
QC	quality control
ROM	Record of Modification
s/cm^2	structures per square centimeter
SAP	sampling and analysis plan
SI	screening investigation
Site	Libby Asbestos Superfund Site
SOP	standard operating procedure
SPF	sample preparation facility
SUA	specific-use area
TEM	transmission electron microscopy
TL	task leader
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VRP	Voluntary Recruitment Program
Weston	Weston Solutions, Inc.

A3. Distribution List

Copies of this completed and signed sampling and analysis plan/quality assurance project plan (SAP/QAPP) should be distributed to:

U.S. Environmental Protection Agency, Region VIII
1595 Wynkoop Street
Denver, Colorado 80202-1129

- Rebecca Thomas, Thomas.Rebecca@epa.gov (electronic copy)
- Elizabeth Fagen, Fagen.Elizabeth@epa.gov (electronic copy)

EPA Information Center
108 East 9th Street
Libby, Montana 59923

- Mike Cirian, Cirian.Mike@epa.gov (1 hard copy, electronic copy)

U.S. Army Corps of Engineers, Omaha District
Attn: CENWO-PM-S
1616 Capitol Avenue
Omaha, Nebraska 68102-4901

- Mary Darling, Mary.N.Darling@usace.army.mil (electronic copy)
- Mark Buss, Mark.E.Buss@usace.army.mil (electronic copy)
- Jeff Hubbard, Jeffrey.W.Hubbard@usace.army.mil (electronic copy)
- Jeremy Ayala, Jeremy.A.Ayala@usace.army.mil (electronic copy)
- Brian Broekemeier, Brian.J.Broekemeier@usace.army.mil (electronic copy)
- Molly Maxwell, Molly.C.Maxwell@usace.army.mil (electronic copy)

Montana Department of Environmental Quality
1100 North Last Chance Gulch
Helena, Montana 59601

- Carolyn Rutland, CRutland@mt.gov (electronic copy)
- John Podolinsky, JPodolinsky@mt.gov (electronic copy)

TechLaw, Inc.
ESAT, Region VIII
16194 West 45th Drive
Golden, Colorado 80403

- Doug Kent, Kent.Doug@epa.gov (electronic copy)

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60 Port Boulevard, Suite 201
Libby, Montana 59923

- Thomas Cook, cookTE@cdmsmith.com (1 hard copy, electronic copy)
- Scott Felton, feltonDS@cdmsmith.com (1 hard copy, electronic copy)
- Kara McKenzie, mckenzieKE@cdmsmith.com (14 hard copies, electronic copy)

Copies of the SAP/QAPP will be distributed to the individuals above by the architectural and engineering contractor (A&E) (CDM Federal Programs Corporation [CDM Smith]), either in hard copy or in electronic format (as indicated above). The A&E's Project Manager (or their designate) will distribute updated copies each time a SAP/QAPP revision occurs. An electronic copy of the final, signed SAP/QAPP (and any subsequent revisions) will also be posted to the Libby Field eRoom.

A4. Project Task Organization

Figure A-1 presents an organizational chart that shows lines of authority and reporting responsibilities for this project. The following sections summarize the entities and individuals that will be responsible for providing project management, technical support, and quality assurance for this project.

A4.1 Project Management

The U.S. Environmental Protection Agency (EPA) is the lead regulatory agency for Superfund activities within the Libby Asbestos Superfund Site (Site). The EPA Region 8 Libby Asbestos Project Team Leader is Rebecca Thomas. The EPA Remedial Project Manager (RPM) for general property investigations (GPIs) is Elizabeth Fagen. The EPA Region 8 Onsite Remedial Project Manager for GPIs is Mike Cirian.

The U.S. Army Corps of Engineers (USACE), Omaha District, is the contracting agency for GPI activities at the Site, on behalf of the EPA. GPI activities will be performed by CDM Smith under contract to the USACE for Architect-Engineering and Surveying Services (Contract Number W9128F-11-D-0023, Task Order 0003) for ongoing response action support to the EPA Region 8. USACE's Project Manager is Mary Darling.

The Montana Department of Environmental Quality (DEQ) is the support regulatory agency for Superfund activities at the Site. The DEQ Project Manager for these activities is Carolyn Rutland. The EPA will consult with DEQ as provided for by the Comprehensive Environmental Response, Compensation, and Liability Act, the National Contingency Plan, and applicable guidance in conducting Superfund activities.

A4.2 Technical Support

A4.2.1 SAP/QAPP Development

This SAP/QAPP was developed by CDM Smith at the direction of, and with oversight by, USACE and the EPA. This SAP/QAPP contains all the elements required for both a SAP and a QAPP and has been developed in general accordance with the *EPA Requirements for Quality*

Assurance Project Plans, EPA QA/R-5 (EPA 2001) and the *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G4* (EPA 2006).

Copies of the SAP/QAPP will be distributed by the A&E's Project Manager (or their designate), either in hard copy or in electronic format, as indicated in Section A3. The A&E's Project Manager (or their designate) will distribute updated copies each time a SAP/QAPP revision occurs. An electronic copy of the final, signed SAP/QAPP (and any subsequent revisions) will also be posted to the Libby Field eRoom.

A4.2.2 Field Sampling Activities

The A&E will be responsible for conducting all field investigation activities described in this SAP/QAPP. Key A&E personnel that will be involved in this investigation program include:

- Thomas Cook, Project Manager
- Scott Felton, Project Engineer
- Kara McKenzie, Task Leader
- Simon Wilson, Field Team Leader
- Tracy Dodge, Sample Coordinator
- Scott Miller, Field Data Manager
- Karen Repine, Property Operations Coordinator
- Terry Crowell, Quality Assurance Coordinator
- Damon Repine, Health and Safety Manager

A4.2.3 Asbestos Analysis

All samples collected as part of this project will be sent for preparation and analysis for asbestos at laboratories selected and approved by the EPA to support the Site. The EPA Environmental Services Assistance Team (ESAT) is responsible for procuring all sample preparation facility (SPF) and analytical laboratory services and providing direction to the entities providing these services. Don Goodrich (EPA Region 8) is responsible for managing the ESAT laboratory support contract for asbestos. The ESAT Region 8 Team Manager at TechLaw, Inc. is Mark McDaniel. He is also the designated laboratory coordinator (LC) for the Libby project that is responsible for directing the analytical laboratories, prioritizing analysis needs, and managing laboratory capacity.

A4.2.4 Data Management

The project data management processes and reporting requirements, and related contractor responsibilities, are described in the *EPA Data Management Plan for the Libby Asbestos Superfund Site* (EPA 2012).

All sample and location data generated as part of GPIs will be managed and maintained in Scribe. The EPA Environmental Response Team (ERT) is responsible for the administration of all Scribe data management aspects of this project. Joseph Schafer is responsible for overseeing the ERT data management support contract. ERT is responsible for the development and management of Scribe and the project-specific data reporting requirements for the Libby project.

CDM Smith's Field Data Manager (Scott Miller) is responsible for overseeing the upload of sample and location information to the field Scribe project database.

ESAT is responsible for uploading new analytical results to the analytical Scribe project database. The ESAT Project Data Manager for the Libby project is Janelle Lohman (TechLaw, Inc.).

In addition to sample and location data, GPI property information (e.g., addresses, property identifiers [IDs], geounit IDs, contacts, access and property statuses) will be managed in EPA's Response Manager database. Weston Solutions, Inc. (Weston) is responsible for administering Response Manager, and Brad Morgan is Weston's Response Manager Administrator.

Limited property coordination (i.e., solicitation attempts to contact property owners for GPI participation) and GPI/design process tracking information will be maintained in the project Property Operations Tracking System. This system is integrated with Response Manager for key property and access data, and is administered by Scott Miller (CDM Smith).

Because of the quantity and complexity of the data collected at the Site, the EPA has designated a Libby Data Manager to manage and oversee the various data support contractors. The EPA Region 8 Data Manager for the Libby project is Jeff Mosal.

A4.3 Quality Assurance

There is no individual designated as the EPA Quality Assurance Manager (QAM) for the Libby project. Rather, the Region 8 QA program has delegated authority to the EPA RPMs. This means that the EPA RPMs have the ability to review and approve governing investigation documents developed by Site contractors. Thus, it is the responsibility of the EPA RPM for GPIs (Elizabeth Fagen), who is independent of the entities planning and obtaining the data, to ensure that this SAP/QAPP has been prepared in accordance with the EPA quality assurance (QA) guidelines and requirements. The EPA RPM is also responsible for managing and overseeing all aspects of the QA and quality control (QC) program for GPIs. In this regard, the RPM is supported by the EPA Quality Assurance Technical Support (QATS) contractor, CB&I Federal Services (CB&I). The QATS contractor will evaluate and monitor laboratory QA/QC and is responsible for performing annual audits of each analytical laboratory. CB&I's QAM for this project is Michael Lenkauskas.

CDM Smith's QA Director, Jo Nell Mullins, implements the CDM Smith QA program. She is independent of project technical staff and reports directly to the president of CDM Smith on QA matters. The QA director has the authority to objectively review projects and identify problems, and the authority to use corporate resources, as necessary, to resolve any quality-related problems. CDM Smith's QA Coordinator for this project, Terry Crowell, reports to Ms. Mullins on QA matters. Under Ms. Mullin's oversight, Ms. Crowell is responsible for monitoring and evaluating field QA/QC, providing oversight of field sampling and data collection activities, and coordinating field QA activities, including identifying qualified, independent staff to conduct assessments of field activities (see Section B5.1.4).

A5. Problem Definition/Background

A5.1 Site Background

Libby is a community in northwestern Montana located 7 miles southwest of a vermiculite mine that operated from the 1920s until 1990. The mine began limited operations in the 1920s and was operated on a larger scale by W.R. Grace and Company from approximately 1963 to 1990. Studies revealed that the vermiculite from the mine contains amphibole-type asbestos, referred to as Libby Amphibole asbestos (LA).

Epidemiological studies revealed that workers at the mine had an increased risk of developing asbestos-related lung disease (McDonald *et al.* 1986, Amandus and Wheeler 1987, Amandus *et al.* 1987, Sullivan 2007). Additionally, radiographic abnormalities were observed in 17.8 percent of the general population of Libby including former workers, family members of workers, and individuals with no specific pathway of exposure (Peipins *et al.* 2003). Although the mine has ceased operations, historic or continuing releases of LA from mine-related materials could be serving as a source of on-going exposure and risk to current and future residents and workers in the area. The Site was listed on the National Priorities List in October 2002.

A5.2 Reasons for this Project

Previous investigations conducted at the Site have demonstrated that LA is present in a variety of media (e.g., soil, bulk materials, dust) from source materials (e.g., vermiculite insulation, vermiculite-containing soils, mining wastes) at properties within operable unit (OU) 4. As a result, individuals may be exposed to LA that is released to air during source disturbance activities. These inhalation exposures may pose a risk of cancer and/or non-cancer effects.

The objectives of the GPI program are twofold:

1. Collect data to confirm the presence/absence of LA and/or LA source materials at residential, commercial, industrial, and public properties within OU4.

2. Collect data to determine the extent of removal activities required at properties within

OU4 where previous investigations indicate the presence of LA and/or LA source materials.

Properties within OU4 require GPIs to meet these goals.

A5.3 Applicable Criteria and Action Limits

At the Libby Site, the EPA has developed action levels and cleanup criteria for LA that are applicable to emergency response actions performed at residential/commercial properties (EPA 2003) (EPA 2011). However, these criteria are not applicable to locations outside of the Site. In addition, final action levels for the Site will not be developed until completion of the remedial investigation/feasibility study and the publication of the record of decision. Thus, there are no LA-specific criteria or action limits that apply to this investigation program.

Personal air monitoring of sampling personnel will be performed in accordance with Occupational Safety and Health Administration (OSHA) requirements, as specified in the Site-specific APP. In accordance with these requirements, samples will be analyzed for asbestos by phase contrast microscopy (PCM) and compared to the OSHA limits for workplace exposures. The short-term (15-minute) exposure limit is 1.0 fiber per cubic centimeter of air (f/cc), and the long-term time-weighted average exposure limit is 0.1 f/cc.

A6. Project/Task Description

A6.1 Task Summary

The GPI process is divided into two distinct phases: screening investigation (SI) and detailed investigation (DI). SIs are intended to screen properties that have not undergone previous investigation, while DIs are performed at properties where a removal trigger has been identified. The SI and DI phases will generally be performed at separate times.

GPIs include the following basic tasks: scheduling the property visit; reviewing previously collected property data; analyzing any archived dust samples; conducting a verbal interview, visually inspecting the property for vermiculite and vermiculite source materials; collecting and analyzing soil samples for asbestos; and preparing a property sketch with visual inspection and analytical results. These tasks are described in greater detail in subsequent sections of this SAP/QAPP.

A6.2 Work Schedule

CDM Smith's current task order with the USACE extends from March 3, 2013 through March 2, 2014. GPIs are generally conducted from April through October, when Site weather is conducive to outdoor field work. Indoor GPIs may be conducted during the off-season; however, require property re-visits (weather permitting) to complete the outdoor portion of the investigation. The overall schedule for implementing the GPI program is determined by the EPA's annual cleanup goals.

A6.3 Locations to be Evaluated

GPI property selection is described in Section B1.1.

A6.4 Resources and Time Constraints

GPI activities may be conducted year-round; however, as noted above, outdoor field work is limited by weather conditions. The number of SIs and DIs performed each year depend upon goals set by the EPA for cleanups and total investigations.

A7. Quality Objectives and Criteria

A7.1 Data Quality Objectives

Data quality objectives (DQOs) are statements that define the type, quality, quantity, purpose, and use of data to be collected. The design of a study is closely tied to the DQOs, which serve as the basis for important decisions regarding key design features such as the number and location of samples to be collected and types of analyses to be performed. The EPA has developed a seven-step process for establishing DQOs to help ensure that data collected during a field investigation program will be adequate to support reliable site-specific decision-making (EPA 2001, 2006).

Appendix A provides the detailed implementation of the seven-step DQO process associated with this SAP/QAPP.

A7.2 Performance Criteria

Because the primary goal of this SAP/QAPP is to provide data for the purposes of determining the extent of any required removal action at each property selected for investigation at the Libby Site, the performance criteria and analytical requirements are based on the requirements specified in the *Action Level/Clearance Criteria Technical Memorandum* (EPA 2003) and the *Action Level/Clearance Criteria Technical Memorandum,* Amendment A (EPA 2011). These requirements are specified as part of the DQOs (see **Appendix A**). The analytical requirements for LA measurements established in Section B4 ensure that results from this study will be directly comparable to results from historical (and planned future) sampling efforts.

A7.3 Precision

The precision of asbestos measurements is determined mainly by the number (N) of asbestos structures counted in each sample. The coefficient of variation resulting from random Poisson counting error is equal to $1/N^{0.5}$. In general, when good precision is needed, it is desirable to count a minimum of 3-10 structures per sample, with counts of 20-25 structures per sample being optimal.

Field duplicates for both SI and DI soil sampling activities will be collected (see Section B2.4). Analysis of these field duplicates will provide a measure of the precision of the sampling and analysis process.

A7.4 Bias and Representativeness

To the extent feasible, GPIs samples should be collected and analyzed in accordance with the procedures set forth in this SAP/QAPP, which are consistent with the previous version of this document. This will ensure that GPI results are representative and appropriate for comparison to other GPI data sets.

A7.5 Completeness

Target completeness for this project is 100 percent (%). That is, 100% of samples collected are expected to be analyzed. If any samples are not analyzed, or if LA analysis is not completed successfully, this could result in incomplete property characterization. In this event, additional sampling may be needed to support EPA decision-making.

A7.6 Comparability

The data generated during this study will be obtained using standard or project-specific analytical methods for LA that have been utilized previously in other studies, and will yield data that are comparable to previous analyses of LA in GPI soil and dust samples.

A7.7 Method Sensitivity

The method sensitivity (analytical sensitivity) needed for LA analysis of each medium is discussed in Section B4.

A8. Special Training/Certifications

A8.1 Field

Asbestos is a hazardous substance that can increase the risk of cancer and serious non-cancer effects in people who are exposed by inhalation. Therefore, all individuals involved in the collection, packaging, and shipment of samples must have appropriate training. Prior to starting any field work, any new GPI field team member must complete the following, at a minimum:

Training Requirement	Location of Documentation Specifying Training Requirement Completion
Read and understand the governing Accident Prevention Plan (APP) (CDM Smith 2013a)	APP signature sheet
Attend an orientation session with the field health and safety (H&S) Manager	Orientation session attendance sheet
OSHA 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) and relevant 8-hour refreshers	OSHA training certificates
Current 40-hour HAZWOPER medical clearance	Physician letter in the field personnel files
Respiratory protection training, as required by 29 Code of Federal Regulations (CFR) 1910.134	Training certificate
Asbestos awareness training, as required by 29 CFR 1910.1001	Training certificate

All H&S-related training documentation will be stored in the A&E's Libby project office. It is the responsibility of the field H&S Manager to ensure that all H&S-related training documentation is up-to-date and on file for each field team member.

Prior to beginning field sampling activities, a field planning meeting will be conducted to discuss and clarify the following:

- Objectives and scope of the fieldwork
- Equipment and training needs
- Field operating procedures, schedules of events, and individual assignments
- QA/QC requirements
- Health and safety requirements

It is the responsibility of each field team member to review and understand all applicable governing documents associated with this investigation program, including this SAP/QAPP, all associated standard operating procedures (SOPs) (see **Appendix B**), and the applicable APP.

A8.2 Laboratory

A8.2.1 Certifications

All analytical laboratories participating in the analysis of samples for the Libby project are subject to national, local, and project-specific certifications and requirements. Each laboratory is accredited by the National Institute of Standards and Technology (NIST)/National Voluntary Laboratory Accreditation Program (NVLAP) for the analysis of airborne asbestos by transmission electron microscope (TEM) and/or analysis of bulk asbestos by polarized light microscopy (PLM). This includes the analysis of NIST/NVLAP standard reference materials, or other verified quantitative standards, and successful participation in two proficiency rounds per year each of bulk asbestos by PLM and airborne asbestos by TEM supplied by NIST/NVLAP.

Copies of recent proficiency examinations from NVLAP or an equivalent program are maintained by each participating analytical laboratory. Many of the laboratories also maintain certifications from other state and local agencies. Copies of all proficiency examinations and certifications are also maintained by the LC.

Each laboratory working on the Libby project is also required to pass an onsite EPA laboratory audit. The details of this EPA audit are discussed in Section B5.3.3. The LC also reserves the right to conduct any additional investigations deemed necessary to determine the ability of each laboratory to perform the work. Each laboratory also maintains appropriate certifications from the state and possibly other certifying bodies for methods and parameters that may also be of interest to the Libby project. These certifications require that each laboratory has all applicable state licenses and employs only qualified personnel. Laboratory personnel working on the Libby project are reviewed for requisite experience and technical competence to perform asbestos analyses. Copies of personnel resumes are maintained for each participating laboratory by the LC in the Libby project file.

A8.2.2 Laboratory Team Training/Mentoring Program

Initial Mentoring

The orientation program to help new laboratories gain the skills needed to perform reliable analyses at the Site involves successful completion of a training/mentoring program that was developed for new laboratories prior to their analysis of Libby field samples. All new laboratories are required to participate in this program. The training program includes a rigorous 2-3 day period of on-site training provided by senior personnel from those laboratories already under contract on the Libby project, with oversight by the QATS contractor. The tutorial process includes a review of morphological, optical, chemical, and electron diffraction characteristics of LA, as well as training on project-specific analytical methodology, documentation, and administrative procedures used on the Libby site. The mentor will also review the analysis of at least one sample by each type of analytical method with the trainee laboratory.

Site-specific Reference Materials

Because LA is not a common form of asbestos, the U.S. Geological Survey (USGS) prepared Site-specific reference materials using LA collected at the Libby mine site (EPA 2008a). Upon entry into the Libby program, each laboratory is provided samples of these LA reference materials. Each laboratory is required to analyze multiple LA structures present in these samples by TEM in order to become familiar with the physical and chemical appearance of LA and to establish a reference library of LA energy dispersive spectroscopy (EDS) spectra. These laboratory-specific and instrument-specific LA reference spectra (EPA 2008b) serve to guide the classification of asbestos structures observed in Libby field samples during TEM analysis.

Regular Technical Discussions

On-going training and communication is an essential component of QA for the Libby project. To ensure that all laboratories are aware of any technical or procedural issues that may arise, a regular teleconference is held between the EPA, their contractors, and each of the participating laboratories. Other experts (e.g., USGS) are invited to participate when needed. These calls cover all aspects of the analytical process, including sample flow, information processing, technical issues, analytical method procedures and development, documentation issues, project-specific laboratory modifications, and pertinent asbestos publications.

Professional/Technical Meetings

Another important aspect of laboratory team training has been the participation in technical conferences. The first of these technical conferences was hosted by USGS in Denver, Colorado, in February 2001, and was followed by another held in December 2002. The Libby laboratory team has also convened on multiple occasions at the American Society for Testing and Materials (ASTM) Johnston Conference in Burlington, Vermont, including in July 2002, July 2005, July 2008, and July 2011, and at the Michael E. Beard Asbestos Conference in San Antonio, Texas in January 2010. In addition, members of the Libby laboratory team attended an EPA workshop to develop a method to determine whether LA is present in a sample of vermiculite attic insulation held in February 2004 in Alexandria, Virginia. These conferences enable the Libby laboratory and technical team members to have an on-going exchange of information regarding all analytical and technical aspects of the project, including the benefits of learning about developments by others.

A8.2.3 Analyst Training

All TEM analysts for the Libby project undergo extensive training to understand TEM theory and the application of standard laboratory procedures and methodologies. The training is typically performed by a combination of personnel, including the Laboratory Manager, the laboratory QAM, and senior TEM analysts.

In addition to the standard TEM training requirements, trainees involved with the Libby project must familiarize themselves with Site-specific method deviations, project-specific documents, and visual references. Standard samples that are often used during TEM training include known pure (traceable) samples of chrysotile, amosite, crocidolite, tremolite, actinolite and anthophyllite, as well as fibrous non-asbestos minerals such as vermiculite, gypsum, antigorite, kaolinite, and sepiolite. New TEM analysts on the Libby project are also required to perform an *EDS Spectra Characterization Study* (EPA 2008b) on the LA-specific reference materials provided during the initial training program to aide in LA mineralogy recognition and definition. Satisfactory completion of each of these tasks must be approved by a senior TEM analyst. All TEM analysts are also trained in the Site-specific laboratory QA/QC program requirements for TEM (see Section B5.3.4). The entire program is discussed to ensure understanding of requirements and responsibilities. In addition, analysts are trained in the project-specific reporting requirements and data reporting tools utilized in transmitting results. Upon completion of training, the TEM analyst is enrolled as an active participant in the Libby laboratory program.

A training checklist or logbook is used to assure that the analyst has satisfactorily completed each specific training requirement. It is the responsibility of the laboratory QAM to ensure that all TEM analysts have completed the required training requirements.

A9. Documentation and Records

A9.1 Field

Field teams will record field information on the most current version of the Site-specific field sample data sheet (FSDS) for soil[1]. Section B3.1.1 provides detailed information on the documentation requirements for FSDS forms. In brief, the FSDS forms document the unique sample ID assigned to every sample collected as part of this program, and also documents location and visual inspection information regardless of whether a sample is collected.

A9.2 Troy Sample Preparation Facility

During sample drying and preparation, detailed information on sample mass during each step of the process is recorded on Site-specific sample drying and preparation log sheets, as provided in Attachment 1 of SOP ISSI-LIBBY-01. As these log sheets are completed, one of the SPF personnel (other than the individual who completed the original log sheet) will check to ensure the data are accurate and complete. If errors are observed during the check, corrections will be made by the person that originally completed the log sheets. All log sheets are maintained and archived at the Troy SPF. Scanned copies of log sheets are maintained on the ESAT network drive. These scanned copies are also emailed to the appropriate Project Data Manager.

A9.3 Laboratory

All preparation and analytical data for asbestos generated in the laboratory will be documented on Site-specific laboratory bench sheets and entered into a database or spreadsheet electronic data deliverable (EDD) for submittal to the ESAT Project Data Manager. Section B4.2 provides detailed information on the requirements for laboratory documentation and records.

[1] The current version of each type of FSDS form is provided in the Libby Field eRoom.

A9.4 Logbooks and Records of Modification

It is the also responsibility of field, Troy SPF, and analytical laboratory staff to maintain logbooks and other internal records throughout the sample lifespan as a record of sample handling procedures. Significant deviations (i.e., those that impact or have the potential to impact investigation objectives) from this SAP/QAPP, or any procedures referenced herein governing sample handling, will be discussed with the EPA RPM (or their designate) and the A&E's Project Manager prior to implementation. Such deviations will be recorded on a Record of Modification (ROM) form[2]. Sections B5.1.2, B5.2.2, and B5.3.2 provide detailed information on the procedures for preparing and submitting ROMs by field, Troy SPF, and analytical laboratory personnel, respectively.

[2] The current version of the field ROM form is provided in the Libby Field eRoom; current versions of the Troy SPF and laboratory ROM forms are provided in the Libby Lab eRoom.

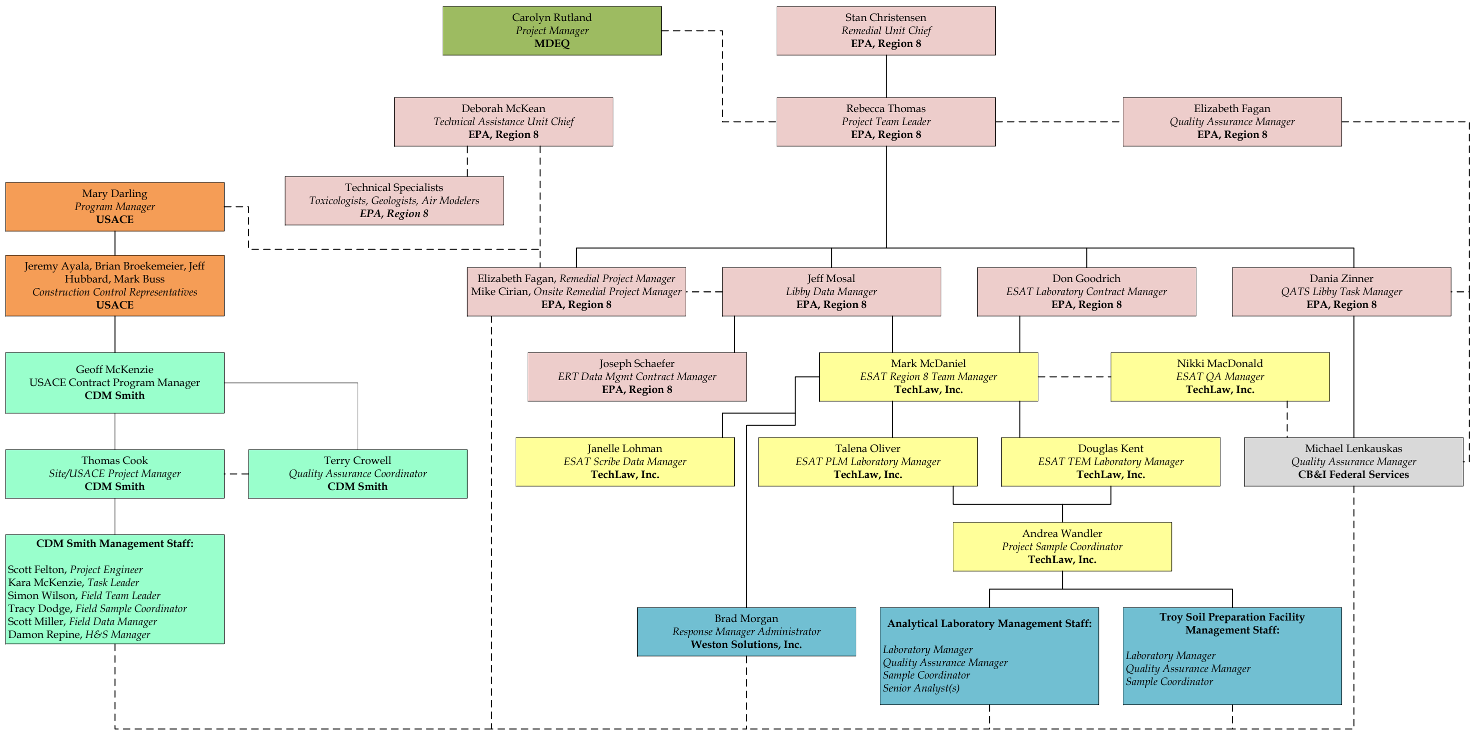

Figure A-1. Organizational Chart for General Property Investigations

EPA Region 8 Staff
USACE Staff
MDEQ Staff
CDM Smith Staff
TechLaw Staff
TechLaw Subcontractors
CB&I Staff
Lines of authority
Lines of communication

B Data Generation and Acquisition

B1. Study Design

B1.1 Locations

Candidate properties within OU4 for GPIs will be identified by the property operations coordinator (POC) based on property statuses maintained in Response Manager. Properties will consist of those with known removal triggers (as defined in EPA's *Draft Final Residential/Commercial Cleanup Action Level and Clearance Criteria Technical Memorandum for the Libby Asbestos Site* [EPA 2003], the *Action Level/Clearance Criteria Technical Memorandum,* Amendment A [EPA 2011] and *Flowerpot Action Level Clarification Memorandum* [CDM Smith 2013b] based on previous investigation data), and those that have not yet undergone initial screening. To the extent possible, investigations will be geographically clustered. The EPA/USACE will provide specific direction for conducting GPIs at properties outside existing Site OUs, which are typically identified through the EPA's Environmental Resource Specialist (ERS) program. **Figure B-1** identifies the site location of the Libby Asbestos Site. **Figure B-2** identifies the OU boundaries for the Libby Asbestos Site.

B1.2 Sampling Design

The following provides an overview of the GPI program that will be conducted. Detailed information on investigation procedures and methods are presented in Section B2.

As previously mentioned, the GPI is designed to screen properties for the presence of LA or LA source materials and determine the extent of LA contamination for subsequent removal. The overall investigation process is outlined in **Figure B-3**. The sampling program is divided into two stages: SIs and DIs. These are discussed in brief below.

SIs involve:

- Property Selection and Communication
- Verbal Interview
- Interior Inspection
- Exterior Inspection
- Screening Documentation

All SI activities will follow a hot-stop process. The purpose of this process is to inspect a property until either the property has been fully characterized, or a removal trigger is identified. If a removal trigger is identified during an SI, the SI will terminate once all interior inspection and sampling is complete. Upon SI termination, a land survey will be ordered and a DI will be scheduled to complete the exterior investigation at a later date.

Current removal triggers are:

- Visual confirmation of open, uncontained, or migrating vermiculite insulation.
- Visual confirmation of vermiculite in an indoor living space (frequently accessed understructures are considered living spaces).
- Concentration of LA in an indoor dust sample greater than or equal to 5,000 LA structures per square centimeter (s/cm^2) using ASTM D5755, with project-modified Asbestos Hazard Emergency Response Act (AHERA) counting methods.
- Visual confirmation of vermiculite or other vermiculite mine-related materials in a specific-use area (SUA). An SUA is defined as a flowerbed, garden, planter, driveway, play area, firepit, or other defined area likely to receive significant use and generally not covered with grass.
- Concentration of LA greater than or equal to 1% in soils by PLM.

DIs are performed to capture additional information on a property to support cleanup activities. DIs are completed at properties that have undergone initial screening and display one or more removal triggers.

DIs involve:

- Property Selection and Communication
- Land Survey (performed by removal contractor)
- Scheduling Investigations
- Review of Previously Collected Data
- Verbal Interview
- Interior Inspection
- Exterior Inspection

Refer to Section B2 for full details on the SI and DI processes.

B1.3 Study Variables

The total number of properties requiring GPI is somewhat variable as geospatial updates are made for the Site, which includes ongoing changes to property boundaries based land survey data and changes in legal ownership (subdivisions and merges). The geospatial update process is outlined in the *EPA Data Management Plan* for the Libby Asbestos Superfund Site (EPA 2012). Notwithstanding geospatial changes, annual GPI planning and implementation will be based on best available property information, as tracked in Response Manager.

Additionally, the number and types of soil samples to be collected and analyzed for each GPI property can be widely variable depending upon property use and size. The time period required to adequately perform each SI will be estimated by the GPI Field Team Leader (FTL) based primarily on available geospatial information; DIs will be scheduled based on a review of the SI documentation and the land survey.

As previously mentioned, weather may also be a constraining factor in performing GPIs. It is anticipated that GPIs will be scheduled during the period of the year most conducive to performing both indoor and outdoor investigation (i.e., the field season); however, it is feasible that indoor work continue during periods of inclement weather (i.e., the off-season).

B1.4 Critical Measurements

The critical measurement associated with this project is determining the nature and extent of LA and LA source materials at OU4 properties. This will be accomplished using both visual inspections and sampling for LA in soil.

There is an established correlation between visible vermiculite and LA content in Site soils. As such, standardized visual inspection protocol for vermiculite will be employed. The standardized visual inspection protocol, CDM-LIBBY-06 (see **Appendix B**), includes a training component to ensure consistency (to the extent possible) between GPI team members in applying the protocol.

The analysis of LA may be achieved using several different types of methods. For GPI efforts, all soil samples (including field duplicate samples) will be analyzed for asbestos by the PLM visual estimation method (PLM-VE) and the PLM gravimetric method (PLM-Grav) in accordance with project-specific SOPs SRC-LIBBY-03 and SRC-LIBBY-01, respectively[3]. To date, these methods have proven to be the most appropriate analytical methods to screen and quantify asbestos in Site source materials.

B1.5 Data Reduction and Interpretation

Data collected as part GPIs are intended to be used to support the OU4 remedial investigation and property-specific removal decisions at the Site.

[3] The current version of each project-specific SOP is provided in the Libby Lab eRoom.

B2. Investigation Methods

This section summarizes field activities that will be performed in support of GPIs within OU4, and outside existing OUs as directed. This section also provides brief summaries of (SOPs), including investigation-specific modifications where applicable and investigation-specific details not discussed in the SOPs. As previously mentioned, the GPI is designed to screen properties for the presence of LA or LA source materials and determine the extent of LA contamination for subsequent removal. The overall investigation process is outlined in **Figure B-3**. The sampling program is divided into two key phases: screening investigation (Section B2.2) and detailed investigation (Section B2.3). Specific details on each type of investigation are discussed within this section.

For comprehensive health and safety information, field personnel will refer to the SOPs included in **Appendix B**. The A&E's APP (CDM Smith 2013a) should be consulted to determine health and safety protocols for performing GPI work.

All sampling activities will be performed in accordance with this SAP/QAPP. The specific procedures that will be employed during GPIs are located in **Appendix B** and listed below:

- Field Logbook Content and Control (SOP EPA-LIBBY-2012-01)
- Photographic Documentation of Field Activities (SOP EPA-LIBBY-2012-02)
- Control of Measurement and Test Equipment (SOP EPA-LIBBY-2012-03)
- Field Equipment Decontamination (SOP EPA-LIBBY-2012-04)
- Handling Investigation-derived Waste (IDW) (SOP EPA-LIBBY-2012-05)
- Sample Custody (SOP EPA-LIBBY-2012-06)
- Packaging and Shipping Environmental Samples (SOP EPA-LIBBY-2012-07)
- Completion of Field Sample Data Sheets (SOP CDM-LIBBY-03)
- Soil Sample Collection at Residential and Commercial Properties (CDM-LIBBY-05)
- Semi-quantitative Visual Estimation of Vermiculite in Soils at Residential and Commercial Properties (CDM-LIBBY-06)
- Global Positioning System (GPS) Coordinate Collection and File Transfer Process (SOP CDM-LIBBY-09)
- Crawlspace Entry (SOP CDM-LIBBY-17)

The following sections summarize field activities that will be performed during the implementation of the sampling investigation efforts described in this SAP/QAPP.

Analytical methods for all samples collected in accordance with this SAP/QAPP are discussed in section B.4.

B2.1 Field Preparation

B2.1.1 Field Team Training

Prior to conducting GPI field activities, any new field team member must complete the following, at a minimum:

- Read the site-specific APP (CDM Smith 2013a)
- Attend an orientation session with A&E's onsite H&S officer
- Read and understand all relevant governing documents
- Attain OSHA 40-hour HAZWOPER certification and relevant 8-hour refresher course certifications
- Attain respiratory protection course certification as required by 29 CFR 1910.134
- Attain asbestos awareness course certification as required by 29 CFR 1910.1001
- Complete training on sample collection techniques to the satisfaction of the GPI Task Leader (TL) or FTL
- Complete training on identifying vermiculite and Libby mine-related materials to the satisfaction of the GPI TL or FTL

Documentation of trainings/certifications will be stored in the Libby project files located at the A&E's Libby project office.

B2.1.2 Field Planning Meeting (Readiness Review)

Prior to beginning field activities, a field planning meeting (FPM) will be conducted by the A&E's investigation TL or FTL, which will be attended by the field team members conducting the work, a member of the A&E's QA staff, and a member of the A&E's H&Sstaff. The agenda, prepared by the TL or FTL, will be reviewed and approved by QA and H&S staff prior to the FPM. A field planning meeting agenda is provided in **Appendix B**. The FPM will briefly address and clarify:

- Documents governing fieldwork that must be onsite
- Any changes in the governing documents
- Objectives and scope of the fieldwork

- Equipment and training needs
- Field operating procedures, schedule of events, and individual assignments
- Required quality control (QC) measures
- Health and safety requirements

During the FPM, copies of the agenda will be distributed and an attendance list will be circulated for signature. The agenda and the completed attendance list will be maintained in the A&E's project files. Additional meetings will be held if major changes to the documents governing fieldwork occur, or the scope of the assignment changes significantly.

Field team members will perform the following activities before and during field activities, as applicable:

- Review and understand applicable governing documents
- Record appropriate levels of documentation regarding activities conducted
- Ensure coordination between key staff, such as the A&E's sample coordinator and the project's removal contractor
- Obtain required sample containers and other supplies
- Obtain, check, and calibrate field sampling equipment
- Obtain and maintain personal protective equipment (PPE)

B2.1.3 Inventory and Procurement of Equipment and Supplies

An inventory of project-procured equipment and supplies will be conducted by the GPI TL or FTL prior to field work. Any additional required equipment or supplies will be procured. Acceptance of equipment, as pertinent, will be verified according to SOP EPA-LIBBY-2012-03, Control and Measurement and Test Equipment (see **Appendix B**). The following equipment is required for sampling activities conducted under this SAP/QAPP:

- Field logbooks
- Indelible ink pens
- Digital camera with memory card, as appropriate
- Sample paperwork and sample labels
- Custody seals
- Plastic zip-top bags

- Soil sampling equipment
- GPS unit(s) (e.g., Trimble® Pathfinder Pro XRS or equivalent) and compass
- PPE as required by the site-specific APP (CDM Smith 2013a)
- Cordless drill and scope
- Ladder(s)
- Standard hand tools (screwdrivers, hammer, pry-bar, etc.)
- Toughbook/laptop computer equipped with the Response Manager application (for completing forms)
- Measuring wheel/tape
- Land survey (hard copy)

B2.2 Screening Investigation

This section describes the sampling methods and procedures that will be used for SIs. SIs are completed at properties that have not previously been fully characterized. The goal of completing an SI is to identify LA and/or potential sources of LA on a given property. The major phases to an SI include:

- Property Selection and Initial Communication
- Verbal Interview
- Interior Inspection
- Exterior Inspection
- Screening Documentation

All SI activities will follow a hot-stop process. The purpose of this process is to inspect a property until either the property has been fully characterized, or a removal trigger is identified. If a removal trigger is identified during an SI, the SI will terminate once all interior inspection and sampling is complete. Upon SI termination, a land survey will be ordered and a DI will be scheduled to complete the exterior investigation at a later date.

Current removal triggers are:

- Visual confirmation of open, uncontained, or migrating vermiculite insulation.
- Visual confirmation of vermiculite in an indoor living space (frequently accessed understructures are considered living spaces).

- Concentration of LA in an indoor dust sample greater than or equal to 5,000 LA s/cm^2 using ASTM D5755, with project-modified AHERA counting methods.
- Visual confirmation of vermiculite or other vermiculite mine-related materials in SUAs. An SUA is defined as a flowerbed, garden, planter, driveway, play area, firepit, or other defined area likely to receive significant use and generally not covered with grass.
- Concentration of LA greater than or equal to 1% in soils by PLM.

B2.2.1 Property Selection and Initial Communication

Property selection and solicitation will be conducted by voluntary recruitment program (VRP) staff in accordance with the Voluntary Recruitment Program Communication and Information Collection Strategy (DEQ 2011).

B2.2.2 Scheduling Screening Investigations

An SI will be scheduled for a time that is convenient for the property owner or tenant to be present and allow access to the interior of each structure/building at the property.

B2.2.3 Verbal Interview

Upon arriving at the property, the investigation team will meet with the property owner or tenants. The investigation team will provide the property owner/tenants with general details on the investigation and removal process, and, to the extent possible, tentative time-frame for future investigation steps, and, if required, removal activities. Additionally, the investigation team will note any pertinent anecdotal information provided by the property owner for removal planning. This information may include scheduling requests, general property information, details on known contamination present at the property, etc. If the property owner was not solicited through the VRP, the investigation team will complete and obtain property owner signatures on the Consent for Access to Property form that will cover inspections to be performed immediately as well as any future exterior investigation activities. Property owners will be notified prior to and may request to be present during any future investigation activities. Access information will be tracked in Response Manager in accordance with EPA project data reporting requirements.

B2.2.4 Interior Screening Inspection

During SI activities, the purpose of the interior inspection is to fully inspect the entire interior of each structure/building on the property to confirm the presence or absence of LA source materials (e.g., raw vermiculite, vermiculite insulation, vermiculite-containing building materials). All inspection information is captured on the Interior Property Inspection Form (IPIF), and associated sketches. Occupant information and history for all occupied buildings is captured on the Occupant Information Form (OIF). The interior of each building on the property will be inspected during SI activities.

In addition, details collected during the interior inspection will be sufficient to support any future removal activities necessary and eliminate the need for subsequent investigation. All interior inspections and sampling will be completed to DI standards, in accordance with Section B2.3.5 of this SAP/QAPP.

B2.2.5 Exterior Screening Inspection

Exterior screening inspections will be performed to identify potential LA source materials within the exterior soils of the property. All inspection information is captured on the FSDSs and associated sketches.

The purpose of the following sections is to detail procedures for conducting exterior inspections, which will be conducted by the A&E and will include the following activities:

- Visual inspection
- Soil sampling
- Exterior inspection documentation

Visual Inspection

Visual inspection of exterior soils will be completed in accordance with CDM-LIBBY-06 with the following exception:

- The number of point inspections to be completed per use area is defined in **Table B-1** (Screening Investigation).

Table B-1 Visual Inspection and Soil Sampling Protocol

Screening Investigation		
Area Type	Visual Inspection Protocol[a]	Soil Sampling Protocol[b,c] Maximum Area per Sample
SUA[d,e] (flowerbed, garden, play area, etc.)	1 PI/100 ft^2	use area
SUA [d,e] (driveway)	1 PI/200 ft^2	use area
CUA [f] (yard, etc.)	1 PI/1,450 ft^2	1 acre (43,560 ft^2)
LUA (field, pasture, etc.)	1 PI/7,260 ft^2	5 acres (217,800 ft^2)
PB (crawlspace, cellar, etc.)	1 PI/100 ft^2	use area
SB (shed, garage, barn, pump house, etc.)	1 PI/100 ft^2	use area
SS [g] (carport, lean-to, etc.)	1 PI/100 ft^2	use area
NUA [h] (wooded area, etc.)	No Inspection	No Sampling
Detailed Investigation		
Area Type	Visual Inspection Protocol[a]	Soil Sampling Protocol[b,d] Maximum Area per Sample
SUA[e] (flowerbed, garden, play area, etc.)	1 PI/100 ft^2	1,000 ft^2
SUA[e] (driveway)	1 PI/200 ft^2	6,000 ft^2
CUA [f] (yard, etc.)	1 PI/100 ft^2	3,000 ft^2
LUA (field, pasture, etc.)	1 PI/500 ft^2	15,000 ft^2
PB (crawlspace, cellar, etc.)	1 PI/100 ft^2	use area
SB (shed, garage, barn, pump house, etc.)	1 PI/100 ft^2	use area
SS [g] (carport, lean-to, etc.)	1 PI/100 ft^2	use area
NUA [h] (wooded area, etc.)	No Inspection	No Sampling

[a] A minimum of five points will be inspected per use area regardless of size.
[b] All soil samples are 30-point composites.
[c] Areas where vermiculite is observed within CUAs and LUAs will be segregated and sampled discretely.
[d] Areas where vermiculite is observed will not be sampled.
[e] Multiple SUAs of the same type (e.g., flowerbeds may only be combined with other flowerbeds) within the same general area may be combined to form one sample area; maximum of six areas can be combined.
[f] Multiple rock beds or bush beds of the same material (e.g., lava rock beds may only be combined with other lava rock beds) within the same general area may be combined to form one sample area; maximum of six areas.
[g] Secondary structures may be combined with the surrounding area provided that the material is the same throughout (e.g., if they contain the same material, a carport may be combined with the driveway)
[h] If inspection of NUA is required, use SUA protocol.

SUA – specific-use area
CUA – common-use area
LUA – limited-use area
NUA – non-use area
PB – primary building
SB – secondary building
SS – secondary structure
PI – point inspection
ft^2 – square feet

Soil Samples

Soil samples will be collected during SIs in order to fully characterize each property. SI samples will only be collected if no removal trigger has been identified.

All SI soil samples will be collected in accordance with CDM-LIBBY-05 with the following exception:

- The maximum area that a single 30-point composite sample may include varies depending on the type of use area. **Table B-1** (Screening Investigation) defines the maximum area per soil sample.
- Rock and shrub beds (common-use areas [CUAs]) may be combined as a sample area if they are proximal and contain the same material. **Table B-1** (Screening Investigation) defines the maximum area per soil sample.
- For landscape features with a solid liner (i.e., no penetrations for plants), the soil beneath the liner will not be inspected or sampled. The location will be identified on the DI sketch.

If vermiculite is observed in CUAs or limited-use areas (LUAs) during the visual inspection, and no removal action level is identified, those areas will be isolated for separate sampling. Each CUA or LUA portion containing visible vermiculite will be sampled separately and in accordance with the sampling guidelines above.

B2.2.6 Screening Documentation

An IPIF will be completed for each primary or secondary building inspected as part of SI activities. An OIF will be completed for each primary building on the property. Example inspection forms are provided in **Appendix C**, and depict the data to be collected. All inspection forms will be completed electronically in the field using a toughbook or laptop equipped with the Response Manager software.

For exterior inspections, sample information and visual inspection results will be recorded on a field sketch. Site-specific sketches will be completed on aerial photographs, scaled graph paper, or equivalent. Sample information and visual inspection results may be broken out into separate sketches if quality and clarity cannot be maintained on a single sketch.

In addition, investigation teams will review and provide feedback to the POC regarding geounit-to-address relationships for appropriate tracking in Response Manager.

B2.2.7 Investigation Complete Notification

Once all SI data is assembled and has been reviewed, the GPI FTL will notify the POC that the SI is complete. This notification will include the completion date, which is considered the date that the sample results are received or the final review is complete, whichever occurs later. This notification will also provide a brief summary of the SI findings.

B2.2.8 Letters to Residents

Following the SI complete notification, for properties where no EPA removal action is anticipated based on SI findings, a property status letter will be prepared by the VRP team. The letter will be drafted using the current and appropriate EPA-approved letter template for No Further Action properties[4], and will be reviewed by a qualified A&E reviewer prior to being mailed to the owner (and tenants, if applicable). A copy of the letter will be maintained in Response Manager in accordance with EPA project document management requirements.

B2.3 Detailed Investigation

This section describes the sampling methods and procedures that will be used to complete DIs. DIs are performed to capture additional information on a property to support cleanup activities. DIs are completed at properties that have undergone initial screening and display one or more removal triggers.

The following is a summary of field activities that will be performed by the A&E during the DI:

- Property selection and communication
- Land survey
- Scheduling investigations
- Review of previously collected data
- Verbal interview
- Interior inspection
- Exterior inspection

B2.3.1 Property Selection and Communication

Properties will be selected for DI from candidate properties requiring removal as tracked in Response Manager. To the extent possible, investigations will be geographically clustered.

B2.3.2 Land Survey

A land survey will be conducted at each property identified for DI activities. Land surveys will include property boundaries to determine the limits of the property for which the removal is being conducted. Surveys will also include major physical and geographic features of the property (e.g., structures/buildings, trees, individual land use areas). The survey contractor will be a registered and licensed land surveyor in the State of Montana. The survey contractor is

[4] Current templates are maintained on the CDM Smith project office server.

currently subcontracted to the project removal contractor (PRI-ER).

If a property is known to require removal based on previous investigation findings, the GPI FTL will notify the project removal contractor to order a land survey. If a removal trigger is identified during an SI, the GPI FTL will notify the POC that the property's status has changed to Removal Required and will notify the removal contractor that a land survey is required. Once received, a hard copy of the land survey will be used by the investigation team to mark soil sample locations and results, locations of visible vermiculite, and additional inspection information. Specific information to be captured by the investigation team is discussed in the following sections.

B2.3.3 Scheduling Detailed Investigations

If a property has undergone SI and/or partial DI activities, and additional investigation activities are required, the property owner will be notified of the preferred time-frame to conduct these activities. If the property owner has requested to be present during all activities, a DI will be scheduled for a time that is convenient for them.

If interior inspections are required during the DI phase, the DI will be scheduled for a time that is convenient for the property owner or tenant to be present and allow access to the interior of each structure/building on the property.

B2.3.4 Previously Collected Data

Prior to arriving at a property, the investigation team will review all previously collected data in order to become familiar with property conditions. Previous data may include Phase 1, Contaminant Screening Study (CSS), and/or SI data (including bulk material, soil, and dust sample results), and data collected during an ERS initial response. A complete set of property-specific data will be obtained from the project database and maintained in the project file folder at the A&E's project office. All existing property documentation (IFF, sample information and results, field logbook notes, ERS Initial Assessment Checklist, IPIF, etc.) will be reviewed to determine the general location of documented contaminated material.

Section B2.3.6 provides guidance on which areas require sampling or re-sampling as a result of previously collected data.

In many cases, dust samples collected during previous investigations were not analyzed but were archived for potential future analysis. The investigation team will coordinate with the A&E sample coordinator to ensure that any necessary dust samples are retrieved from archive and analyzed.

If a verbal interview has not yet been conducted with the property owner, the DI team will conduct a verbal interview during the site visit and complete applicable forms in accordance with Section B2.2.3.

B2.3.5 Interior Detailed Inspection

Interior detailed inspections will be performed when previous investigation findings indicate either contamination is present or unknown within buildings (e.g., house, garage, shed, barn) on the property. To the extent possible, all interior detailed inspections will be completed during the SI phase. A&E interior inspection activities include:

- Attic inspection
- Living space assessment and wall inspection
- Understructure inspection
- Interior soil samples, as required
- Interior inspection documentation

Interior inspections will be performed to determine the location and extent of contaminated materials within a building. Information will also be collected regarding the general construction and condition of the building, and access to contaminated materials. Interior inspections will include attic spaces, living spaces, and understructures (e.g., basement, cellar, crawlspace).

B2.3.5.1 Attic Inspection

Attic inspections will be completed when previous inspections indicate the presence of vermiculite insulation, or if the presence/absence of vermiculite could not be confirmed during previous investigations. Attic inspections will be limited to confirming the presence/absence of vermiculite insulation and collecting sufficient details to support removal activities. All attic spaces will be inspected until either vermiculite insulation is confirmed, or until the entire attic has been inspected and no vermiculite insulation is present.

Once vermiculite insulation is confirmed in an attic space, inspection ceases and general details for the entire attic (including areas that share air space but do not contain vermiculite insulation) will be collected from that location. Detailed information about the attic space will be collected during the Interior Property Removal Evaluation as discussed in the Response Action Work Plan, Revision 5 (PRI-ER 2013).

Attic details will be recorded on the IPIF and associated sketch(es) as discussed in Section B2.3.5.5.

B2.3.5.2 Living Space Assessment and Wall Inspection

Interior living spaces will be inspected to determine if vermiculite materials are present. Vermiculite may appear in living spaces as insulation that is leaking from the attic or walls, or as an additive in building materials. Living space assessments will include inspecting all walls, all ceiling and wall penetrations (plumbing, heating, ventilation and air conditioning [HVAC] systems, electrical fixtures, cracks, gaps, etc.), and plaster/mortar materials. If vermiculite additives are identified within building materials, the location will be noted on the interior sketch. The vermiculite-containing building material will be evaluated to determine whether it is friable (i.e., able to be pulverized by hand) and a note indicating the condition will be included on the interior sketch as well.

Based on previous investigation findings, small amounts of vermiculite insulation are likely to be present within wall cavities of structures/buildings that have vermiculite attic insulation. If vermiculite insulation is observed within the attic of a structure/building, it will be assumed that the walls below those attic sections contain some amount of vermiculite and those walls will not be inspected using intrusive methods. This will be noted within the interior inspection documentation as detailed in Section B2.3.5.5.

In addition, previous investigations have found vermiculite insulation used as primary insulation within wall cavities. All walls will be inspected to determine if significant vermiculite insulation is present. At least one location along each exterior and interior wall will be inspected. Non-destructive inspection methods will be utilized when possible. This will include removing electrical outlet and switch covers, and inspecting through other existing wall penetrations. Destructive inspection methods (i.e., drill/scope) will be used only when no existing penetrations are present. If destructive methods are required, care will be taken to minimize damage and inspections will be carried out within inconspicuous areas. The investigation team will seal all new penetrations with appropriate patching material.

Living space details will be recorded on the IPIF and associated sketch(es) as discussed in Section B2.3.5.5.

B2.3.5.3 Understructure Inspection

Building understructures will be inspected to determine if vermiculite materials are present. Vermiculite may appear in understructures as insulation that is leaking from the attic or walls, as additives in building materials, or as vermiculite in soil floors. Understructure inspections will include inspecting all ceiling and wall penetrations (plumbing, HVAC, electrical, cracks, gaps, fixtures, etc.), plaster/mortar materials, and inspecting soil floors. If the building understructure has a soil floor, a visual inspection will be completed per Section B2.3.6.1 of this SAP/QAPP. If vermiculite is not observed within the soil floor, soil samples will be collected as discussed in Section B2.3.6.2.

Understructure details will be recorded on the IPIF and associated sketch(es) as discussed in Section B2.3.5.5.

In addition to general details, the investigation team will make a determination as to the frequency the understructure is accessed. Understructures will be categorized as frequently accessed, infrequently accessed, or a combination of the two (for separate areas). In general, understructures will be considered infrequently accessed if they are accessed on average no more than once monthly, and the activities being conducted involve minimal soil disturbance. Understructures that are accessed on average more than once monthly, or if activities during access include significant soil disturbance (e.g., digging), will be considered frequently accessed. Understructure remediation criteria is discussed in the Final Response Action Work Plan, Revision 5 (PRI-ER 2013).

B2.3.5.4 Interior Soil Samples

Soil samples will be collected from inside a building only if significant soil areas are present (e.g., soil floor). Interior soil samples will be collected, where vermiculite was not observed during visual inspection, unless the visible vermiculite was localized and segregated from sample collection. Individual flower pots/planters will not be sampled. Soil samples will be collected in accordance with Section B2.3.6.2 of this SAP/QAPP.

B2.3.5.5 Interior Inspection Documentation

An IPIF will be completed for each primary or secondary building inspected as part of this SAP/QAPP. IPIFs will be completed electronically in real-time in the field using the Response Manager software. Attic, living space, and understructure sketches will accompany each IPIF as appropriate. Sketches can either be specific to the area inspected, or part of the exterior sketch. Sketches will include the details indicated in **Table B-2**. Sketches will only be prepared for the levels/floors of the structure where LA source materials are observed and/or where samples are collected.

Investigation teams will collect digital photographs in accordance with Section B3.1.4 of this SAP/QAPP. Photographs will include access points, interior hazards, pre-existing conditions, vermiculite, and general interior photographs.

Table B-2 Investigation Sketch Details

<table>
<tr><th colspan="3">General Sketch Details
To be included on all field sketches</th></tr>
<tr><td colspan="3">▪ Property address
▪ AD number
▪ BD number (for interior sketches)
▪ Inspection date
▪ Personnel (author)
▪ North arrow
▪ Scale (if applicable)
▪ Sketch description (e.g. attic, first floor, exterior analytical, exterior visual inspection, etc.)</td></tr>
<tr><th colspan="3">Interior Inspection Sketch Details</th></tr>
<tr><th>Attic</th><th>Living Space</th><th>Understructure</th></tr>
<tr><td>▪ Plan view/layout – including dimensions
▪ Types of insulation
▪ Depth of insulation
▪ Attic accesses - location and size
▪ Head space – structure cross-section
▪ Hazards (in attic and near access)
▪ Obstacles
▪ Joist – size and spacing
▪ Flooring (above and below joist)</td><td>▪ Floor plan/layout
▪ Location of contaminated materials</td><td>▪ Soil samples – locations and results
▪ Visual inspection results
▪ Floor types – soil versus solid flooring
▪ Access – location and size
▪ Headspace</td></tr>
<tr><th colspan="3">Exterior Inspection Sketch Details</th></tr>
<tr><th colspan="3">Visual & Analytical Sketch</th></tr>
<tr><td colspan="3">▪ Soil samples – locations and results
  – Sample ID
  – Location ID
▪ Visual inspection – location and results
  – Visual vermiculite quantity and number of observations
  – Location ID
▪ Location IDs for all primary and secondary buildings on the property
▪ Personal items within areas requiring removal
▪ Fence lines
▪ Underground utilities – if known
▪ Overhead utilities – if not shown on survey</td></tr>
</table>

B2.3.6 Exterior Detailed Inspection

Exterior detailed inspections will be performed at properties where previously collected data indicates the presence of a current removal trigger. Exterior inspections are performed to further define the location and extent of contaminated material and to ensure that the entire property has been characterized. All inspection information is captured on the FSDSs and associated sketches.

A&E exterior inspection activities include:

- Visual inspection
- Soil sampling
- Exterior inspection documentation

B2.3.6.1 Visual Inspection

Visual inspection of exterior soils will be completed in accordance with CDM-LIBBY-06 (see **Appendix B**) with the following exceptions:

- The number of point inspections to be completed per use area is defined in **Table B-1** (Detailed Investigation).
- Areas that have been previously characterized and the presence of contamination has been confirmed (e.g., analytical results indicating the presence of LA) will not be visually inspected.
- In general, non-use areas (NUAs) are not inspected as part of this SAP/QAPP. However, NUAs will be inspected if: 1) LA source materials are observed in adjacent areas and it appears to continue into the NUA, or 2) if the property owner provides information that indicates LA source materials may be present within a specific portion of the NUA. In this case, the area of concern within the NUA will be inspected as an SUA utilizing the guidelines outlined **in Table B-1**.

B2.3.6.2 Soil Sampling

In general, three types of samples will be collected during DIs: characterization samples, re-characterization samples, and delineation samples. The purpose of these different sample types is to utilize previously collected samples/results, while correcting previous protocol issues. These types of samples are described below.

<u>Characterization Samples</u>

Previous investigation/screening activities focused only on high traffic areas of the property; therefore, some portions of the property may not have been sampled. Characterization samples will be collected to characterize use areas that were not previously sampled.

<u>Re-characterization Samples</u>

Soil samples were collected during previous investigation/screening activities to determine the presence or absence of LA within soil. These samples were generally collected as 5-point composite samples from relatively large areas. Re-characterization samples will be collected from all previously sampled areas where previous sampling protocol was employed and results did not indicate LA (i.e., were none detected).

<u>Delineation Samples</u>

Soil samples were collected during previous investigation/screening activities to determine the presence/absence of LA within soil, and were collected to characterize relatively large areas. Delineation samples will be collected to further define the extent and boundary of contamination. Delineation samples will be collected from areas where previous sample results indicate the presence of LA but where the sampled area exceeds the maximum area per DI soil sample as outlined in **Table B-1**.

Sample Collection Methods

All DI soil samples will be collected in accordance with SOP CDM-LIBBY-05 (see **Appendix B**) with the following exceptions:

- The maximum area that a single 30-point composite sample may include varies depending on the type of use area. **Table B-1** (Detailed Investigation) defines the maximum area per soil sample.

- Rock and shrub beds (CUAs) may be combined as a sample area if they are proximal and contain the same material. **Table B-1** (Detailed Investigation) defines the maximum area per soil sample.

- For landscape features with a solid liner (i.e., no penetrations for plants), the soil beneath the liner will not be inspected or sampled. The location will be identified on the DI sketch.

- Soil samples will not be collected in areas where vermiculite materials are observed. It should be noted that this approach is different than SI soil sampling procedures for areas where vermiculite was observed, as discussed in Section B2.2.5. Soil samples may be collected from areas where vermiculite is observed at the direction of USACE or EPA.

B2.3.6.3 Exterior Inspection Documentation

Sample information and visual inspection results will be recorded on a field sketch. If available, a property survey will be utilized as the baseline for these sketches. If a property survey is not available, aerial photographs, scaled graph paper, or an equivalent will be used. Sample information and visual inspection results may be broken out onto separate sketches if quality and clarity cannot be maintained on a single sketch. Sketches will include the details indicated in **Table B-2**. Field sketches will be used to generate removal plans and as such must be neat and legible.

Investigation teams will collect digital photographs in accordance with Section B3.1.4of this SAP/QAPP. Photographs will include access points, exterior hazards, pre-existing conditions, all areas where LA source materials are observed, and general exterior photographs.

In addition, investigation teams will review and provide feedback to the POC regarding geounit-to-address relationships for appropriate tracking in Response Manager.

B2.4 Field Quality Control Samples

Field QC samples associated with soil samples are field duplicate samples. These samples are discussed in this section and summarized in **Table B-3**.

Field duplicate samples for both SI and DI soil sampling activities will be collected at a rate of 1 per 20 field samples collected. Field duplicate samples will be collected from areas that are being sampled during one of the investigation activities discussed in the previous sections. However, individual composite points for the duplicate sample will be collected from different locations within the same use area than the original sample. Field duplicate samples will be collected in accordance with CDM-LIBBY-05 (see **Appendix B**). There is currently no acceptance criteria established for soil field duplicates. Field duplicate sample results may be used in lieu of parent sample results for removal decisions. The investigation TL or FTL are responsible for maintaining overall GPI program soil field duplicate sample collection frequencies.

Table B-3 Summary of Field QC Samples

Sample Type	Associated QC Sample	Collection Frequency	Analysis Frequency	Analysis Request
Soil	field duplicate	1 per 20 field samples	100%	PLM-VE/PLM-Grav

PLM-VE – polarized light microscopy visual area estimation method
PLM-Grav – polarized light microscopy gravimetric method

B2.5 General Processes

This section describes the general field processes that will be used to support the sampling described in this SAP/QAPP and includes references to the site-specific SOPs and project-specific procedures when applicable.

B2.5.1 Equipment Decontamination

Decontamination of reusable field equipment will be conducted in accordance with SOP EPA-LIBBY-2012-04, *Field Equipment Decontamination* (see **Appendix B**). Materials used in the decontamination process will be disposed of as IDW as described below.

B2.5.2 Investigation-derived Waste

IDW at each property will consist of excess sample volume, spent decontamination supplies, and PPE. All IDW will be handled in accordance with SOP EPA-LIBBY-2012-05, *Handling Investigation-derived Waste* (see **Appendix B**). In brief, IDW will be double-bagged in clear 6-mil poly bags with 'IDW' written in indelible ink on the outer bag. All IDW generated during GPIs will remain in the custody of the field team until it can be entered into the waste stream at the local class IV asbestos landfill.

B3. Samples and Locations

B3.1 Field Documentation

In accordance with the A&E's records retention policy, all hard copy field documentation generated as part of GPIs will be retained for a minimum of 10 years, or as otherwise directed by the EPA/USACE.

B3.1.1 Field Sample Data Sheets

As noted previously in Section A9, an FSDS will be completed for each GPI sample in accordance with SOP CDM-LIBBY-03, *Completion of Field Sample Data Sheets* (see **Appendix B**). Use of standardized forms ensures consistent documentation across samplers. Current versions of media-specific FSDSs are provided in the Libby Field eRoom. FSDSs are location-specific and allow for the entry of up to three individual samples from the same location on the same FSDS form. If columns are left incomplete due to fewer than three samples being recorded on a sheet, the blank columns will be crossed out, dated, and signed by the field team member completing the FSDS. Erroneous information recorded on a hard copy FSDS will be corrected with a single line strikeout, initial, and date. The correct information will be entered in close proximity to the erroneous entry.

An event ID will be recorded on each FSDS to identify the protocol used for the inspection(s) or sample(s) recorded on that FSDS. For inspections and samples collected under the SI protocol, event ID SI-041513 will be used. For inspections and samples collected under the DI protocol, event ID DI-041513 will be used.

A unique alphanumeric code, or location ID, will identify each location inspected or sampled during GPI activities. The coding system will provide a tracking record to allow retrieval of information about a particular location and to ensure that each is uniquely identified. Location IDs will be sequential and will be recorded on the FSDS. For locations where a sample was collected, both the location ID and sample ID will appear on the FSDS.

FSDS information will be completed in the field before field personnel leave the sampling location. To ensure that all applicable data is accurately entered and all fields are complete, a different field team member will check each FSDS. The team member completing the hard copy form and the team member checking the form will initial the FSDS in the proper fields. In addition, the FTL will also complete periodic checks of FSDSs prior to relinquishment of the samples to the field sample coordinator. Once FSDSs and samples are relinquished to the field sample coordination staff, the FSDSs are again checked for accuracy and completeness when data are input into the local Scribe field database.

If a revision is required to the hard copy FSDS during any of these checks, it will be returned to the field team member initially responsible for its completion. The error will be explained to the team member and the FSDS corrected. If the team member is no longer on site, revisions will be made by sample coordination staff or the FTL. It is the responsibility of the Field Data Manager to make the appropriate change in the local Scribe field database.

Each hard copy FSDS is assigned a unique sequential number. This number will be referenced in the field logbook entries related to samples recorded on individual sheets. A&E field administrative staff will manage the hard copy FSDSs in the A&E Libby project office. Original FSDSs will be filed by medium and FSDS number.

B3.1.2 Sample and Location Labeling

A unique alphanumeric sample ID will identify each sample collected during GPIs. Sample IDs provide a tracking record to allow retrieval of information about a particular sample from collection through final archive or disposal. Sample IDs will be sequential and will not be representative of any particular building or equipment. Sample IDs will correlate with sample location IDs, which will be identified on FSDSs.

The GPI sample labeling scheme is as follows:

4G-XXXXX

Where:

4G identifies that a sample is collected in accordance with this SAP/QAPP, and
XXXXX represents a unique, 5-digit number

Preprinted adhesive sample labels are required to be signed out by sampling personnel. The labels are controlled to prevent duplication in assigning sample IDs. The labels will be affixed to both the inner and outer sample bags for soil samples. Sample labels will be used in accordance with SOP EPA-LIBBY-2012-06, *Sample Custody* (see **Appendix B**).

The location labeling scheme for GPIs is as follows:

XX-###### or

BD-######

Where:

XX identifies exterior locations,
BD identifies interior locations, and
represents a 6-digit numeric code

B3.1.3 Field Logbooks

The field logbook is an accounting of GPI activities and will duly note problems or deviations from this SAP/QAPP. Field logbook entries will be recorded in accordance with SOP EPA-LIBBY-2012-01, *Field Logbook Content and Control* (see **Appendix B**). Sample details will be recorded on an FSDS and FSDS numbers will be recorded in the logbook.

A&E field administrative staff will manage the field logbooks by assigning unique identification numbers to each field logbook, tracking to whom and the date each field logbook was assigned, the type of activities recorded in each field logbook (i.e., GPIs), and the date when the field logbook was returned. As field logbooks are completed, originals will be catalogued and maintained in the A&E project office. Scanned copies of field logbooks will be maintained on the CDM Smith project server, which is backed up daily to an offsite location.

B3.1.4 Photographic Documentation

All photographic documentation will be in accordance with SOP EPA-LIBBY-2012-02, *Photographic Documentation of Field Activities* (see **Appendix B**). Captions are not required for photographs taken as part of this SAP/QAPP.

Photographs will be taken with a digital camera at any place that field personnel determine necessary. Electronic photograph files will be saved each day to the A&E's server located at the Libby project office (backed up daily to an offsite location), and named so that photographs for a particular property or activity can easily be retrieved. The GPI photograph file naming convention is as follows:

45 Montana Ave_DI_092113_001

Where:

45 Montana Ave = the address where GPI activities occurred
DI or SI = the specific activity being documented
092113 = the date the photograph was taken (MMDDYY)
001 = the number of the photograph taken at that property that day

Following completion of GPI activities, all photographic files pertaining to a property will be copied to the A&E server and ultimately copied onto compact disc and filed in Libby along with other property-specific documentation.

B3.1.5 Change Control

Corrections to field documentation, including FSDSs and logbooks, require a single strikeout of the erroneous information, initials, and date. The corrected information should be entered in close proximity to the existing entry. For revisions to FSDSs, it is the responsibility of investigation staff making the revisions to provide the revised originals to the A&E's sample coordinator for updating corresponding electronic data. Updated FSDS data will be published to Scribe by A&E data management staff promptly in order to meet the EPA reporting requirements.

All deviations from the guiding documents will be recorded in the logbooks by the investigation team or on the Record of Modification to Documents Governing Field Activities by the FTL (see Section B5.1.2 for specifics).

B3.1.6 Global Positioning System Coordinate Collection

GPS location coordinates will be collected during SIs for inspected or sampled locations in accordance with SOP CDM-LIBBY-09, *GPS Coordinate Collection and Handling* (see **Appendix B**). Location coordinates for DIs will be sourced from the geo-referenced property survey by the drafters and provided to the data management team for review and publishing to Scribe. Coordinates for buildings will be collected only if the building does not already have an assigned GPS location.

Field-collected GPS data are converted to a usable geographic information system (GIS) format using the general processes described in SOP CDM-LIBBY-09. After the conversion from GPS points to GIS files, 100% of the data is checked visually to identify any potential data entry errors.

B3.1.7 Field Sample Custody

Sample custody and documentation will follow the requirements specified in SOP EPA-LIBBY-2012-06, *Sample Custody* (see **Appendix B**). In general, all teams will ensure that samples, while in their possession, are maintained in a secure manner to prevent tampering, damage, or loss. At the end of each day, investigation teams will relinquish samples directly to sample coordination staff or to a designated secure sample storage location. Relinquishment will be documented in the logbook.

B3.1.8 Chain-of-Custody Requirements

For the Libby project, the chain-of-custody (COC) record is employed as physical evidence of sample custody and condition from the sample coordination team to the receiving facility. A completed COC record is required to accompany each batch of samples, whether it is hand-delivered to the EPA LC or shipped to a processing or analytical facility.

The sample coordination team will produce COC records in accordance with the EPA Data Management Plan (EPA 2012). Only quality-checked sample information will be used for COC records. In the event that electronic systems are unavailable (e.g., due to a power outage), hard copy COC records will be employed. Any hard copy COC records will be data-entered as soon as electronic systems are back online.

For hand-deliveries, a sample coordinator will relinquish samples and corresponding COC records to the EPA LC under strict custody. During relinquishment, the sample coordinator will complete the following information in the designated spaces at the bottom of the COC record: signature, company name, date, and time. The EPA LC will also complete the required information and will make a note regarding sample condition (e.g., OK – accept). The sample coordinator will retain the bottom copy of the COC record for the A&E's project record.

B3.1.9 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with SOP EPA-LIBBY-2012-07, Packaging and Shipping of Environmental Samples (see **Appendix B**). Samples will be hand-delivered to the EPA LC, picked up by a delivery service courier, or shipped by a delivery service to the designated facility or laboratory, as applicable. For hand-deliveries, the sample coordinator will package samples for transit such that they are contained and secure (i.e., will not be excessively jostled). Clean plastic totes with the lids secured or sample coolers may be used for this purpose.

B3.1.10 Field Equipment Maintenance

Field equipment maintenance will be conducted and documented in accordance with SOP EPA-LIBBY-2012-03, Control of Measurement and Test Equipment (see **Appendix B**).

B3.2 Holding Times

For the samples specified for collection in this SAP/QAPP, no holding time requirements will be employed.

B3.3 Archival and Final Disposition

All samples and grids will be maintained in storage at the Troy SPF or analytical laboratory unless otherwise directed by the EPA. When authorized by the EPA, the laboratory will be responsible for proper disposal of any remaining samples, sample containers, shipping containers, and packing materials in accordance with sound environmental practice, based on the sample analytical results. The laboratory will maintain proper records of waste disposal methods, and will have disposal company contracts on file for inspection.

B4. Analytical Methods and Operations

The EPA will be responsible for all sample analysis, including any sample processing prior to analysis. The A&E will be responsible for relinquishing all samples to the EPA LC, or processing facility or laboratory as designated by the EPA LC. The A&E sample coordinator will also be responsible for communicating with the EPA LC to relay pertinent sample and analysis information including sample quantities; special sample handling requirements, processing, or analysis concerns; and requested turn-around times.

This section discusses the analytical methods, custody and documentation procedures, QA/QC requirements, and data management requirements to be employed by the laboratory in support of property investigation activities.

B4.1 Analytical Methods and Turnaround Times

This section describes the analytical methods used for SI and DI samples.

An analytical requirements summary sheet (see **Appendix D**) specific to sampling activities associated with this SAP/QAPP will be distributed by the EPA, and reviewed and approved by all participating laboratories prior to any sample handling.

The A&E's sample coordinator will provide the EPA LC with requested turn-around times for all samples relinquished. In general, it is expected that analysis, including soil preparation, for all SI and DI soil samples will be complete within 10 (business) days and archived dust samples will be complete within 5 (business) days from the time the laboratory receives them.

B4.1.1 PLM-VE/PLM-Grav – Soil Samples

Prior to analysis, all soil samples require a processing step. Soil samples will be processed using the current version of the Libby soil sample processing SOP ISSI-LIBBY-01 (see **Appendix B**) and the procedures included in the *Soil Preparation Work Plan* (TechLaw 2007). The A&E will indicate the current version of the soil sample processing SOP in the analysis request section of the COC record. It is the responsibility of the soil preparation facility to specify the appropriate PLM method as it corresponds to the specific sample fraction being submitted for analysis (i.e., fine ground or coarse fraction) on their COC records to the laboratory.

All soil samples collected as part of this effort, including field duplicate samples, will be analyzed for asbestos by PLM-VE and PLM-Grav in accordance with SOPs SRC-LIBBY-03 and SRC-LIBBY-01 (see **Appendix B**), respectively.

B4.1.2 TEM – Dust Samples

Dust samples will not be collected as part of this SAP/QAPP. However, archived dust samples collected as part of previous investigations (i.e., CSS) will be analyzed to support the removal decision being determined as part of this SAP/QAPP. The A&E investigation teams will identify all archived dust samples that require analysis and communicate this to the A&E sample coordinator.

All archived CSS dust samples will be analyzed by TEM in accordance with the project-amended ASTM D5755 method as described in SOP SRC-LIBBY-05 (see **Appendix B**).

The laboratory will achieve the target method analytical sensitivity of 1,000 per square centimeter using direct preparation techniques. If necessary to achieve the target analytical sensitivity, indirect preparation techniques may be used as described in EPA-LIBBY-08 (see **Appendix B**).

B4.2 Analytical Data Reports

An analytical data report will be prepared by the laboratory and submitted to the appropriate LC after the completion of all required analyses within a specific laboratory job (or sample delivery group). This analytical data report may vary by laboratory and analytical method but generally includes a case narrative that briefly describes the number of samples, the analyses, and any analytical difficulties or QA/QC issues associated with the submitted samples. The data report will also include copies of the signed COC forms, analytical data summaries, a QC package, and raw data. Raw data is to consist of instrument preparation logs, instrument printouts, and QC sample results including, instrument maintenance records, COC check-in and tracking, raw data instrument print outs of sample results, analysis run logs, and sample preparation logs. The laboratory will provide an electronic scanned copy of the analytical data report to the LC and others, as directed by the LC.

B4.3 Laboratory Data Reporting Tools

Standardized data reporting tools (i.e., EDDs) have been developed specifically for the Libby project to ensure consistency between different laboratories in the presentation and submittal of analytical data. In general, unique Libby-specific EDDs have been developed for each analytical method and each medium. Since the beginning of the Libby project, each EDD has undergone continued development and refinement to better accommodate current and anticipated future data needs and requirements. EDD refinement continues based on laboratory and data user input. Electronic copies of all current EDD templates are provided in the Libby Lab eRoom.

For TEM analyses, detailed raw structure data will be recorded and results will be transmitted using the Libby-specific EDDs for TEM. For PLM analyses, optical property details and results will be recorded on the Libby-specific EDDs for PLM. Standard project data reporting requirements will be met for TEM and PLM analyses. EDDs will be transmitted electronically (*via* email) to the following:

- Doug Kent, Kent.Doug@epa.gov
- Janelle Lohman, Lohman.Janelle@epa.gov
- Tracy Dodge, DodgeTA@cdmsmith.com
- Phyllis Haugen, HaugenPJ@cdmsmith.com
- Libby project email address for CDM Smith, libby@cdmsmith.com

ESAT is in the process of developing a new Site-specific analytical results reporting tool, referred to as the Libby Asbestos Data Tool (LADT). This tool is a relational Microsoft® Access database with a series of standard data entry forms specific to each analytical method. The LADT creates a Microsoft® Excel export file that can be directly uploaded into an analytical Scribe project database (see Section B10.4). Laboratories have the option of using LADT as a data reporting method instead of the Libby-specific EDDs.

B4.4 Custody Procedures

Laboratory custody procedures are provided in the QA management plans for each laboratory. These plans were independently audited and found to be satisfactory by the EPA's laboratory audit team.

The basic laboratory sample custody process is as described herein. Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipment and the individual samples. This inspection will include verifying sample integrity. The accompanying COC record will be cross-referenced with all of the samples in the shipment. The laboratory sample custodian will sign the COC record and maintain a copy for their project files; the original COC record will be appended to the hard copy data report. Next, the sample custodian may assign a unique laboratory number to each sample on receipt. This number will identify the sample through all further handling at the laboratory. It is the laboratory's responsibility to maintain internal logbooks and records throughout sample preparation, analysis, data reporting, and sample archiving.

B5. Quality Assurance/Quality Control

B5.1 Field

Field QA/QC activities include all processes and procedures that have been designed to ensure that field samples are collected and documented properly, and that any issues/deficiencies associated with field data collection or sample processing are quickly identified and rectified.

B5.1.1 Training

Before performing field work in Libby, field personnel are required to read all governing field guidance documents relevant to the work being performed and attend a field planning meeting specific to GPI sampling efforts. Additional information on field training requirements is provided in Section A8.1.

B5.1.2 Modification Documentation

All major field deviations from and modifications to this SAP/QAPP will be recorded on the Libby field ROM Form. The field ROM forms will be used to document all permanent and temporary changes to procedures contained in guidance documents governing investigation work that have the potential to impact data quality or usability. Any minor deviations (i.e., those that will not impact data quality or usability) will be documented in the field logbooks. ROMs are completed by the FTL overseeing the investigation/activity, or by assigned field or technical staff. As modifications to governing documents are implemented, the FTL will communicate the changes to the field teams conducting activities associated with the modification.

Each completed field ROM is assigned a unique sequential number (e.g., LFO-000026) by the CDM Smith project QA Coordinator. A ROM tracking log for all field modifications is also maintained by the QA Coordinator. This tracking log briefly describes the ROM being documented, as well as ROM author, the reviewers, and date of approval. Once a form is prepared, it is submitted to the appropriate EPA RPM for review and approval. Approved field

ROMs are maintained on the CDM Smith project server, which is backed up daily to an offsite location.

B5.1.3 Field Surveillances

Field surveillances consist of periodic observations made to evaluate continued adherence to investigation-specific governing documents. It is not anticipated that a field surveillance will be performed for GPI sampling efforts. However, field surveillances may be conducted if field processes are revised or other QA/QC procedures indicate potential deficiencies.

B5.1.4 Field Audits

Field audits are broader in scope than field surveillances. Audits are evaluations conducted by qualified technical or QA staff that are independent of the activities audited. Field audits can be conducted by field contractors, internal EPA staff, or EPA contracted auditors. It is the responsibility of the EPA RPM to ensure that field auditing requirements are met for each investigation. Due to the level of effort for sampling and the duration of the activities discussed in this SAP/QAPP, a field audit will be scheduled for GPIs annually. Office audit frequency will be in accordance with contract requirements. Laboratory system assessments/audits will be coordinated by the EPA.

B5.1.5 Field QC Samples

Field QC samples are typically collected to help ensure that field samples are not contaminated from exogenous sources during sample collection, and to help evaluate the precision of field sample analytical results. Field QC samples are assigned unique field IDs and are submitted to the analytical laboratory along with the associated field samples. For GPIs, field duplicate soil samples will be collected as described in section B2.4.

B5.2 Troy SPF

Prior to shipment to a laboratory for analysis, soil samples will be dried at the Troy SPF. The sections below provide detailed information on QA/QC procedures for the Troy SPF, which is maintained by adherence to standard preparation procedures, submission of preparation QC samples, facilities monitoring, and audits.

B5.2.1 Training/Certifications

Personnel performing sample preparation activities must have read and understood the *Soil Sample Preparation Work Plan*, the *SPF HASP*, and all associated SOPs and governing documents for soil preparation (e.g., SOP ISSI-LIBBY-01). In addition, all personnel must have completed 40-hour OSHA HAZWOPER training, annual updates, annual respirator fit tests, and annual or semi-annual physicals, as required.

Prior to performing activities at the Troy SPF, new personnel will be instructed by an experienced member of the SPF staff and training sessions will be documented in the SPF project files. It is the responsibility of the SPF QAM to ensure that all personnel have completed the required training requirements.

B5.2.2 Modification Documentation

When changes or revisions are needed to improve or document specifics about sample preparation procedures used by the Troy SPF, these changes are documented using an SPF ROM form. The SPF ROM form provides a standardized format for tracking procedural changes in sample preparation and allows project managers to assess potential impacts on the quality of the data being collected. SPF ROMs will be completed by the appropriate SPF or technical staff. Once a form is prepared, it is submitted to the ESAT QAM (or their designate) for review. Final review and approval is provided by the appropriate EPA RPM. Copies of approved SPF ROMs are available in the Libby Lab eRoom.

B5.2.3 Soil Preparation Facility Audits

Internal audits of the SPF are conducted by the SPF QAM periodically to evaluate personnel in their day-to-day activities and to ensure that all processes and procedures are performed in accordance with governing documents and SOPs. All aspects of sample preparation, as well as sample handling, custody, and shipping are evaluated. If any issues are identified, SPF personnel are notified and retrained as appropriate. Audit reports will be completed following each laboratory audit. A copy of the internal audit report, as well as any corrective action reports, will be provided to the LC and the QATS contractor.

Internal audits will be conducted following any significant procedural changes to the soil preparation processes or other SPF governing documents, to ensure the new methods are implemented and followed appropriately.

The Troy SPF is also required to participate in an annual on-site laboratory audit carried out by the EPA through the QATS contract. Audits consist of an evaluation of facility practices and procedures associated with the preparation of soil samples. A checklist of requirements, as derived from the applicable governing documents and SOPs, is prepared by the auditor prior to the audit, and used during the on-site evaluation. Evaluation of the facility is made by reviewing SPF documentation, observing sample processing, and interviewing personnel.

It is the responsibility of the QATS contractor to prepare an On-site Audit Report following the SPF audit. The On-site Audit Report includes both a summary of the audit results and completed checklist(s), as well as recommendations for corrective actions, as appropriate. Responses from each SPF to any deficiencies noted in the On-site Audit Report are also maintained with the respective reports.

It is the responsibility of the QATS contractor to prepare an On-Site Audit Trend Analysis Report on an annual basis. This report shall include a compilation and trend analysis of the on-site audit findings and recommendations. The purpose of this reported is to identify SPF performance problems and isolate the potential causes.

B5.2.4 Preparation QC Samples

Four types of preparation QC samples are collected during the soil preparation process: sand blanks, drying blanks, and preparation duplicates. Each type of preparation QC sample is described in more detail below.

<u>Sand Blank</u>

A sand blank is a sample of store-bought quartz sand that is analyzed to ensure that the quartz sand matrix used for drying and grinding blanks is asbestos-free. Detailed procedures for this certification process are provided in ESAT SOP PLM-02.00, *Blank Sand Certification by Polarized Light Microscopy*. In brief, about 800 grams of sand are split into 40 sand blank aliquots of roughly equal size. Each sand blank is evaluated using stereomicroscopic examination and analyzed by PLM-VE. If a sand blank has detected asbestos, it is re-analyzed by a second PLM analyst to verify the presence of asbestos. The sand is certified as asbestos-free if all 40 sand blanks are non-detect for asbestos. The sand is rejected for use if any asbestos is detected in the sand blanks. Only sand that is certified as asbestos-free will be utilized in the SPF.

<u>Drying Blank</u>

A drying blank consists of approximately 100 to 200 grams of asbestos-free quartz sand that is processed with each batch of field samples that are dried together (usually this is approximately 125 samples per batch). The drying blank is then processed identically to field samples. Drying blanks determine if cross-contamination between samples is occurring during sample drying. One drying blank will be processed with each drying batch per oven. It is the responsibility of the SPF QAM to ensure that the appropriate number of drying blanks is collected. Each drying blank is given unique sample number that is investigation-specific, as provided by the field sample coordinator (i.e., a subset of sample numbers for each investigation will be provided for use by the SPF). SPF personnel will record the sample number of the drying blank on the sample drying log sheet.

It is the responsibility of the QATS contractor to review the drying blank results and notify the SPF QAM immediately if drying blank results do not meet acceptance criteria and if corrective actions are necessary. If asbestos is detected in the drying blank, a qualifier of "DB" will be added to the related field sample results in the project database that were dried at the same time as the detected drying blank to denote that the associated drying blank had detected asbestos. In addition, the drying oven will be thoroughly cleaned. If asbestos continues to be detected in drying blanks after cleaning occurs, sample processing must stop and the drying method and decontamination procedures will be evaluated to rectify any cross-contamination issues.

Preparation Duplicate

Preparation duplicates are splits of field samples submitted for sample preparation. The preparation duplicates are used to evaluate the variability that arises during the soil preparation and analysis steps. After drying, but prior to sieving, a preparation duplicate is prepared by using a riffle splitter to divide the field sample (after an archive split has been created) into two approximately equal portions, creating a parent and duplicate sample.

Preparation duplicate samples are prepared at a rate of 1 per 20 samples (5%) of samples prepared. It is the responsibility of the SPF QAM to ensure that the appropriate number of preparation duplicates is prepared. Each preparation duplicate is given unique sample number that is investigation-specific, as provided by the field sample coordinator. SPF personnel will record the sample number of the preparation duplicate and its associated parent field sample on the sample preparation log sheet. Preparation duplicates are submitted blind to the laboratory for analysis by the same analytical method as the parent sample.

Preparation duplicate results will be compared to the original parent field sample using the Poisson ratio test using a 90% CI (Nelson 1982). Because preparation duplicate samples may have inherent small-scale variability that is random and may be either small or large, there is no quantitative requirement for the agreement of preparation duplicates. Rather, results are used to determine the magnitude of this variability to evaluate data usability. The QATS contractor will notify the SPF QAM when preparation duplicate results are statistically different from the parent results to determine if corrective action is needed.

B5.2.5 Performance Evaluation Standards

The USGS has prepared several Site-specific reference materials of LA in soil that are utilized as performance evaluation (PE) standards to evaluate laboratory accuracy and precision. These PE standards are kept in storage at the Troy SPF and are inserted into the sample train in accordance with SOP ISSI-LIBBY-01, with the following project-specific modification:

- PE standards will not be processed prior to insertion (i.e., no sieving or grinding of the standard should be performed).

PE standards of varying nominal levels will be inserted on a quarterly basis at a rate of at least one PE standard per analytical laboratory.

It is the responsibility of the SPF QAM to ensure that the appropriate number of PE standards is inserted. Each PE standard is given unique sample number that is investigation-specific, as provided by the field sample coordinator. SPF personnel will record the sample number of the

PE standard, the nominal level of the PE standard, and whether it was inserted pre- or post-processing on the sample preparation log sheet. PE standards are submitted blind to the laboratory for analysis by the same analytical method as the field samples.

Results for PE standards will be evaluated by the QATS contractor or their designate. PE standard results that are prepared by FBAS and analyzed by TEM will be compared to results by the nominal concentration of the PE standard. The LC should be notified if PE standard results do not meet acceptance criteria. Corrective action will be taken if the PE standards demonstrate issues with accuracy and/or bias in results reporting. Examples of corrective actions that may be taken include reanalysis and/or repreparation, collaboration between and among laboratories to address potential differences in analysis methods, and analyst re-training.

B5.3 Analytical Laboratory

Laboratory QA/QC activities include all processes and procedures that have been designed to ensure that data generated by an analytical laboratory are of high quality and that any problems in sample preparation or analysis that may occur are quickly identified and rectified. The following sections describe each of the components of the analytical laboratory QA/QC program implemented at the Site.

B5.3.1 Training/Certifications

All analytical laboratories participating in the analysis of samples for the Libby project are subject to national, local, and project-specific certifications and requirements. Additional information on laboratory training and certification requirements is provided in Section A8.2.

Laboratories handling samples collected as part of this investigation program will be provided a copy of and will adhere to the requirements of this SAP/QAPP. Samples collected under this SAP/QAPP will be analyzed in accordance with standard EPA and/or nationally-recognized analytical procedures (i.e., Good Laboratory Practices) in order to provide analytical data of known quality and consistency.

B5.3.2 Modification Documentation

All deviations from project-specific and method analytical guidance documents, or this SAP/QAPP, will be recorded on the Request for Modification to Laboratory Activities or Request for Modification to Soil Sample Preparation Activities form as appropriate. Any deviations that impact, or have the potential to impact, investigation objectives will be discussed with the OU4 EPA Remedial Project Manager and A&E FTL prior to implementation. In addition, the appropriate record of modification form will be used to document any information of interest as requested by the EPA. As modifications are approved by the EPA and implemented, the EPA LC will communicate the changes to the EPA laboratories.

Sample results data will be delivered to the EPA in accordance with the current version of the EPA Data Management Plan (EPA 2012).

B5.3.3 Laboratory Audits

Each laboratory working on the Libby project is required to participate in an annual on-site laboratory audit carried out by the EPA through the QATS contract. These audits are performed by EPA personnel (and their contractors), that are external to and independent of, the Libby laboratory team members. These audits ensure that each analytical laboratory meets the basic capability and quality standards associated with analytical methods for asbestos used at the Libby site. They also provide information on the availability of sufficient laboratory capacity to meet potential testing needs associated with the Site.

External Audits

Audits consist of several days of technical and evidentiary review of each laboratory. The technical portion of the audit involves an evaluation of laboratory practices and procedures associated with the preparation and analysis of samples for the identification of asbestos. The evidentiary portion of the audit involves an evaluation of data packages, record keeping, SOPs, and the laboratory *QA Management Plan*. A checklist of method-specific requirements for the commonly used methods for asbestos analysis is prepared by the auditor prior to the audit, and used during the on-site laboratory evaluation.

Evaluation of the capability for a laboratory to analyze a sample by a specific method is made by observing analysts performing actual sample analyses and interviewing each analyst responsible for the analyses. Observations and responses to questions concerning items on each method-specific checklist are noted. The determination as to whether the laboratory has the capability to analyze a sample by a specific method depends on how well the analysts follow the protocols detailed in the formal method, how well the analysts follow the laboratory-specific method SOPs, and how the analysts respond to method-specific questions.

Evaluation of the laboratory to be sufficient in the evidentiary aspect of the audit is made by reviewing laboratory documentation and interviewing laboratory personnel responsible for maintaining laboratory documentation. This includes personnel responsible for sample check-in, data review, QA procedures, document control, and record archiving. Certain analysts responsible for method quality control, instrument calibration, and document control are also interviewed in this aspect of the audit. Determination as to the capability to be sufficient in this aspect is made based on staff responses to questions and a review of archived data packages and QC documents.

It is the responsibility of the QATS contractor to prepare an On-site Audit Report for each analytical laboratory participating in the Libby program. These reports are handled as business confidential items. The On-site Audit Report includes both a summary of the audit results and

completed checklist(s), as well as recommendations for corrective actions, as appropriate. Responses from each laboratory to any deficiencies noted in the On-site Audit Report are also maintained with the respective reports.
It is the responsibility of the QATS contractor to prepare an On-Site Audit Trend Analysis Report on an annual basis. This report shall include a compilation and trend analysis of the on-site audit findings and recommendations. The purpose of this reported is to identify common asbestos laboratory performance problems and isolate the potential causes.

<u>Internal Audits</u>

Each laboratory will also conduct periodic internal audits of their specific operations. Details on these internal audits are provided in the laboratory *QA Management Plan*. The laboratory QAM should immediately contact the LC and the QATS contractor if any issues are identified during internal audits that may impact data quality.

B5.3.4 Laboratory QC Analyses

<u>General Requirements</u>

The Libby-specific QC requirements for TEM analyses of asbestos are patterned after the requirements set forth by NVLAP. In brief, there are three types of laboratory-based QC analyses for TEM – laboratory blanks, recounts, and repreparations. Detailed information on the Libby-specific requirements for each type of TEM QC analysis, including the minimum frequency rates, selection procedures, acceptance criteria, and corrective actions are provided in the most recent version of Libby Laboratory Modification LB-000029.

With the exception of inter-laboratory analyses, it is the responsibility of the Laboratory Manager to ensure that the proper number of TEM QC analyses is completed. Inter-laboratory analyses for TEM will be selected *post hoc* by the QATS contractor or their designate in accordance with the selection procedures presented in LB-000029. The LC will provide the list of selected inter-laboratory analyses to the Laboratory Manager and will facilitate the exchange of samples between the analytical laboratories.

B6/B7. Instrument Maintenance and Calibration

B6/B7.1 Field Equipment

All field equipment (e.g., sampling shovels, ladders, GPS units) should be maintained in basic accordance with manufacturer specifications. When a piece of equipment is found to be operating incorrectly, the piece of equipment will be labeled "out of order" and placed in a separate area from the rest of the sampling equipment. The person who identified the equipment as "out of order" will notify the FTL overseeing the investigation activities. It is the responsibility of the FLT to facilitate repair of the out-of-order equipment. This may include having appropriately trained field team members complete the repair or shipping the malfunctioning equipment to the manufacturer. Field team members will have access to basic tools required to make field acceptable repairs. This will ensure timely repair of any "out of order" equipment.

B6/B7.2 Laboratory Instruments

All laboratory instruments used for this project will be maintained and calibrated in accordance with the manufacturer's instructions. If any deficiencies in instrument function are identified, all analyses shall be halted until the deficiency is corrected. The laboratory shall maintain a log that documents all routine maintenance and calibration activities, as well as any significant repair events, including documentation that the deficiency has been corrected.

B8. Inspection/Acceptance of Supplies and Consumables

B8.1 Field

In advance of field activities, the GPI TL or FTL will check the field equipment/supply inventory and procure any additional equipment and supplies that are needed. The GPI TL or FTL will also ensure any in-house measurement and test equipment used to collect data/samples as part of this SAP/QAPP is in good, working order, and any procured equipment is acceptance tested prior to use. Any items that the GPI TL or FTL determines unacceptable will be removed from inventory and repaired or replaced as necessary. The inventory and procurement of equipment and supplies is further described in section *B2.1.3.*

B8.2 Laboratory

The Laboratory Manager is responsible for ensuring that all reagents and disposable equipment used in this project is free of asbestos contamination. This is demonstrated by the collection of blank samples, as described in Section B5.

B9. Non-direct Measurements

The EPA has conducted previous investigations at the Site to evaluate the nature and extent of LA and LA source materials at OU4 properties (e.g., CSS). As part of these studies, LA has been measured in dust and soil. The dust and soil sample results from the GPI program may be compared to existing and future Libby data sets for these environmental media. Note that dust samples were collected under previous investigations and will only be analyzed under the GPI program.

Data users will utilize the appropriate project databases to access data for comparison. See Sections B10.4 and B10.5 for additional information on project databases and data reporting.

Only those data that have undergone data verification and validation (see Section D2) and been evaluated with regard to data usability (see Section D3) should be utilized for the purposes of making comparisons.

B10. Data Management

The following subsections describe the field, Troy SPF, and analytical laboratory data management procedures and requirements for this investigation. These subsections also describe the project databases utilized to manage and report data from this investigation. Detailed information regarding data management procedures and requirements can be found in the *EPA Data Management Plan* for the Libby Asbestos Superfund Site (EPA 2012).

B10.1 Field Data Management

Scribe is a software tool developed by ERT to assist in the process of managing environmental data. A Scribe project is a Microsoft Access database. Data for the Site are captured in various Scribe projects. Additional information regarding Scribe and the Libby Scribe project databases is discussed in Section B10.3.

The Field Data Manager utilizes a "local" field Scribe project database (i.e., LibbyCDM_Field.mdb) to maintain field sample information. The term "local" denotes that the database resides on the server or personal computer of the entity that is responsible for the creating/managing the database. It is the responsibility of the Field Data Manager to ensure that all local field Scribe project databases are backed-up nightly to a local server.

Field sample information from the FSDS is manually entered by a member of the A&E's sample coordination staff using a series of standardized data entry forms (i.e., DE Tool). This tool is a Microsoft Access database that was originally developed by ESAT. The DE Tool is currently maintained by CDM Smith and resides on the local server in the project office. This tool is used to prepare an electronic COC. Data in the DE Tool are imported into the local field Scribe project database by the Field Data Manager.

It is the responsibility of the Field Data Manager to "publish" sample and COC information from the local field Scribe database to Scribe.NET on a daily basis. It is not until a database has been published via Scribe.NET that it becomes available to external users.

B10.2 Troy SPF Data Management

The Troy SPF utilizes a local SPF Scribe project database to maintain soil sample preparation information. Soil preparation information from the preparation log sheets is entered into the local SPF Scribe project database by SPF personnel. After the data entry is checked against the original forms, it is the responsibility of the SPF Manager (or their designate) to publish soil sample preparation information from the local SPF Scribe database to Scribe.NET.

B10.3 Analytical Laboratory Data Management

The analytical laboratories utilize several standardized data reporting tools developed specifically for the Libby project to ensure consistency between laboratories in the presentation and submittal of analytical data. In general, a unique Libby-specific EDD has been developed for each analytical method and each sampling medium. Electronic copies of all current EDD templates are provided in the Libby Lab eRoom.

Once the analytical laboratory has populated the EDD with results, the spreadsheet(s) are transmitted via email to the ESAT TEM Laboratory Manager, the ESAT Project Data Manager, and the FTL (or their designate). (Other email recipients may also be specified by the ESAT LC).

The ESAT Project Data Manager utilizes a local analytical Scribe project database (i.e., LibbyLab2012.mdb) to maintain analytical results information. The EDDs are uploaded directly into the analytical Scribe project database. It is the responsibility of the ESAT Project Data Manager to publish analytical results information from the local analytical Scribe database to Scribe.NET.

B10.4 Libby Project Database

As noted above, Scribe is a software tool developed by ERT to assist in the process of managing environmental data. A Scribe project is a Microsoft Access database. Multiple Scribe projects can be stored and shared through Scribe.NET, which is a web-based portal that allows multiple data users controlled access to Scribe projects. Local Scribe projects are “published” to Scribe.NET by the entity responsible for managing the local Scribe project. External data users may “subscribe” to the published Scribe projects via Scribe.NET to access data. Subscription requests are managed by ERT.

All data collected for this investigation will be maintained in Scribe. As discussed above, data will be are captured in various Scribe project databases, including a field Scribe project (i.e., LibbyCDM_Field.mdb) and an analytical results Scribe project (i.e., LibbyLab2012.mdb).

B10.5 Data Reporting

Data users can access data for the Libby project through Scribe.NET. To access data, a data user must first download the Scribe application from the EPA ERT website[5]. The data user must then subscribe to each of the published Scribe projects for the Site using login and password information that are specific to each individual Scribe project. Scribe subscriptions for the Libby project are managed by ERT. Using the Scribe application, a data user may download a copy of any published Scribe project database to their local hard drive. It is the responsibility of the data user to regularly update their local copies of the Libby Scribe projects via Scribe.NET.

The Scribe application provides several standard queries that can be used to summarize and view results within an individual Scribe project. However, these standard Scribe queries cannot be used to summarize results across multiple Scribe projects (e.g., it is not possible to query both field and lab projects using these standard Scribe queries).

If data users wish to summarize results across multiple published Scribe projects, there are two potential options. Data users may request the development of a "combined" project from ERT. This combined project compiles tables from multiple published Scribe projects into a single Scribe project. This allows data users to utilize the standard Scribe queries to summarize and view results.

Alternatively, data users may download copies of multiple published Scribe project databases for the Site and utilize Microsoft Access to create user-defined queries to extract the desired data across Scribe projects. This requires that the data user is proficient in Microsoft Access and has an intimate knowledge of proper querying methods for asbestos data for the Site.

It is the responsibility of the data users to perform a review of results generated by any data queries and standard reports to ensure that they are accurate, complete, and representative. If issues are identified by the data user, they should be reported to the EPA Region 8 Data Manager for resolution via email (Mosal.Jeffrey@epa.gov). It is the responsibility of the EPA Region 8 Data Manager to notify the appropriate entity (e.g., field, Troy SPF, analytical laboratory) in order to rectify the issue. A follow-up email will be sent to the party reporting the issue to serve as confirmation that a resolution has been reached and any necessary changes have been made.

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[5] http://www.ertsupport.org/scribe_home.htm

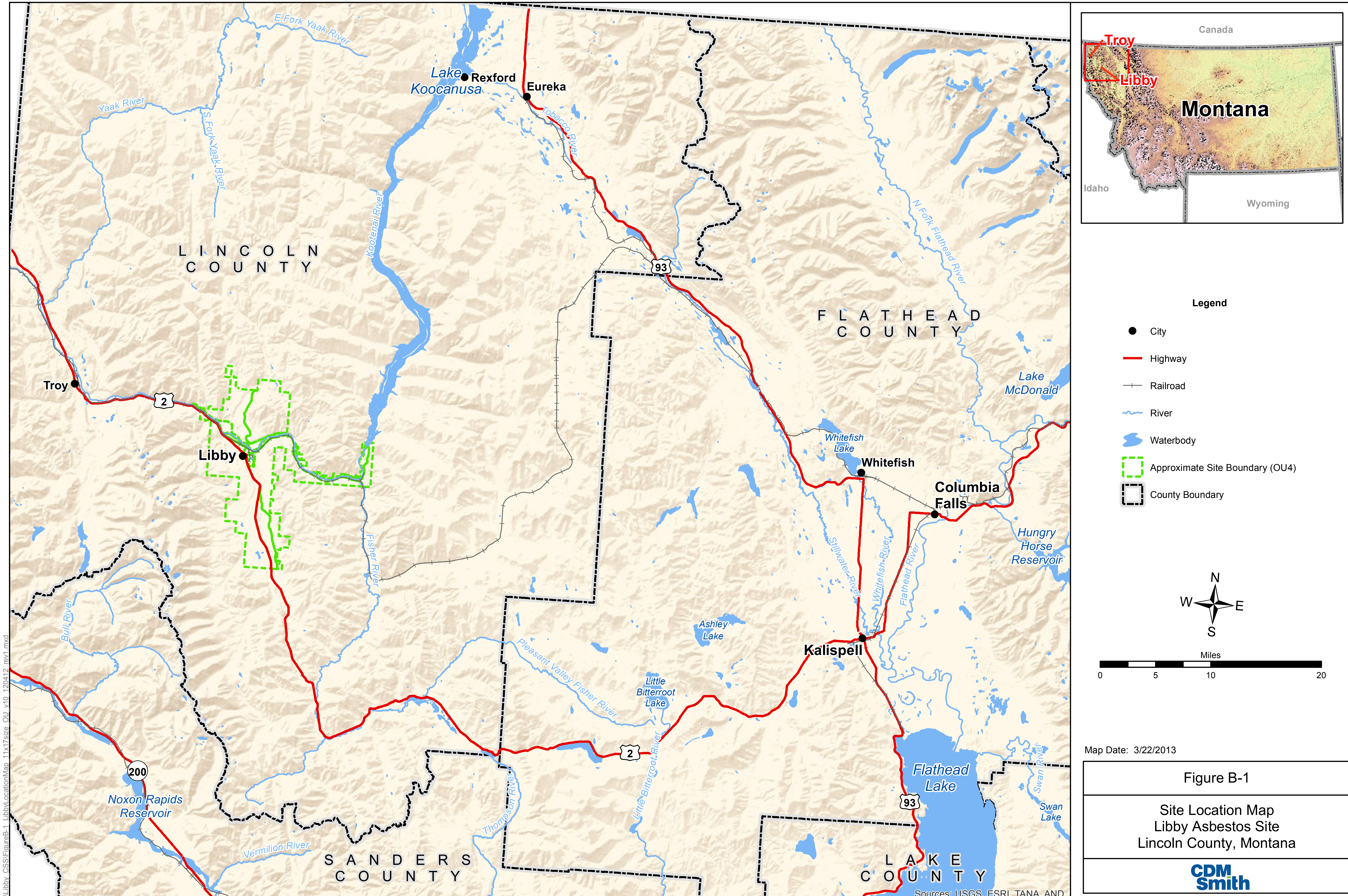
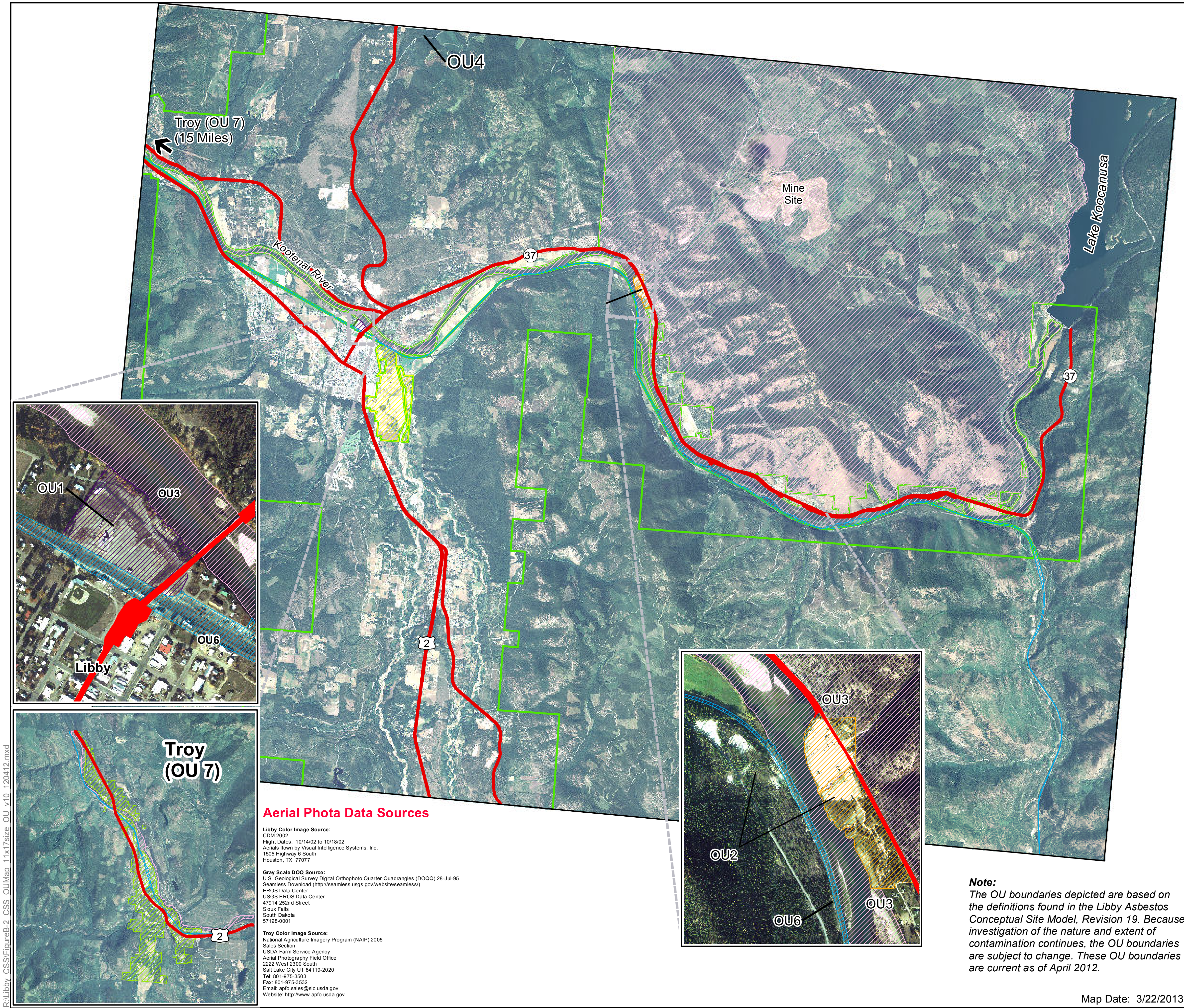


Figure B-1

Site Location Map
Libby Asbestos Site
Lincoln County, Montana



Aerial Phota Data Sources

Libby Color Image Source:
CDM 2002
Flight Dates: 10/14/02 to 10/18/02
Aerials flown by Visual Intelligence Systems, Inc.
1505 Highway 6 South
Houston, TX 77077

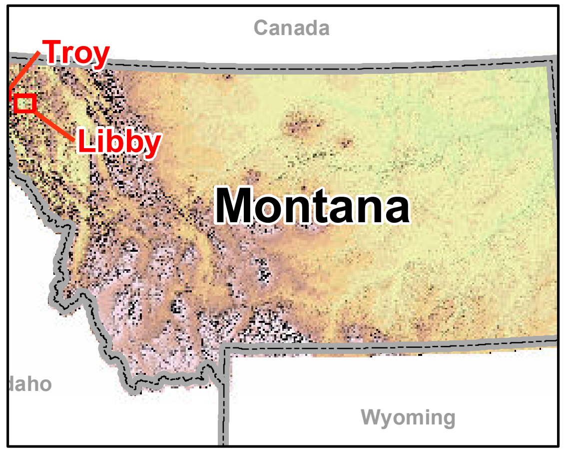
Gray Scale DOQ Source:
U.S. Geological Survey Digital Orthophoto Quarter-Quadrangles (DOQQ) 28-Jul-95
Seamless Download (http://seamless.usgs.gov/website/seamless/)
EROS Data Center
USGS EROS Data Center
47914 252nd Street
Sioux Falls
South Dakota
57198-0001

Troy Color Image Source:
National Agriculture Imagery Program (NAIP) 2005
Sales Section
USDA Farm Service Agency
Aerial Photography Field Office
2222 West 2300 South
Salt Lake City UT 84119-2020
Tel: 801-975-3503
Fax: 801-975-3532
Email: apfo.sales@slc.usda.gov
Website: http://www.apfo.usda.gov

Note:
The OU boundaries depicted are based on the definitions found in the Libby Asbestos Conceptual Site Model, Revision 19. Because investigation of the nature and extent of contamination continues, the OU boundaries are subject to change. These OU boundaries are current as of April 2012.

Map Date: 3/22/2013

R:\Libby_CSS\FigureB-2_CSS_OUMap_11x17size_OU_v10_120412.mxd



Legend

- OU1 - Former Export Plant
- OU2 - Former Screening Plant, Flyway Property, Highway 37 right-of-way adjacent to the Screeing Plant, and the KDC Bluffs
- OU3 - Mine site area, Kootenai River, Rainy Creek and Rainy Creek Road
- OU4 - Residential, Commercial, Industrial Properties including Schools and Parks
- OU5 - Former Stimson Lumber Mill
- OU6 - BNSF Railyard, Tracks, and Right -of-way
- OU7 - Troy
- OU8 - United States and Montana State Highway Right-of-Ways

N W E S

Miles
0 1 2 4

Figure B-2

Operable Unit (OU) Boundaries
Libby Asbestos Site
Libby, Montana

CDM Smith

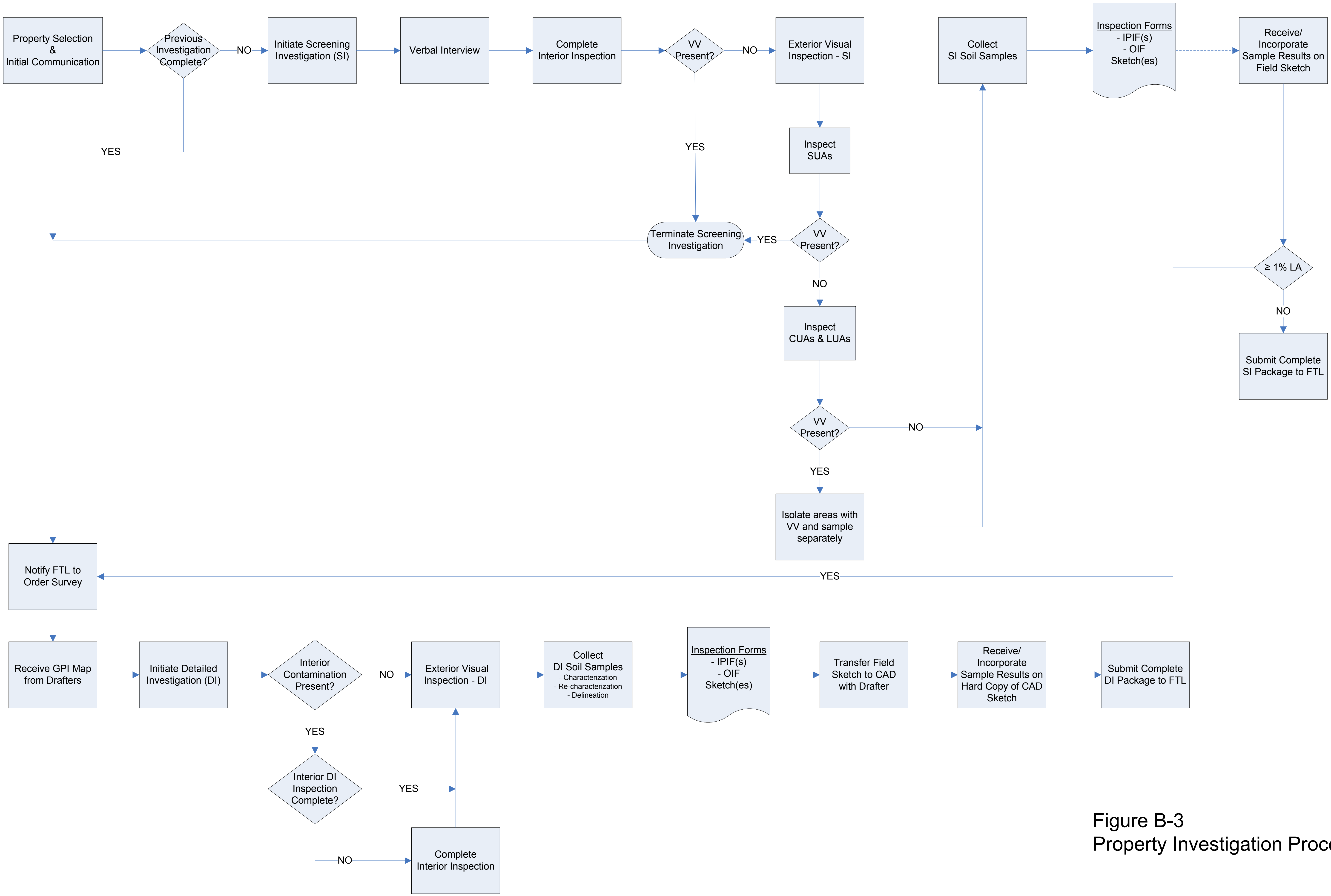


Figure B-3
Property Investigation Process

C1. Assessment and Response Actions

Assessments and oversight reports to management are necessary to ensure that procedures are followed as required and that deviations from procedures are documented. These reports also serve to keep management current on field activities.

C1.1 Assessments

Performance assessments are quantitative checks on the quality of a measurement system and are appropriate to analytical work. Performance assessments for the laboratories may be accomplished by submitting blind reference material (i.e., performance evaluation samples). These assessment samples are samples with known concentrations that are submitted to the laboratories without identifying them as such to the laboratories. Performance assessments will be coordinated by the EPA.

System assessments are qualitative reviews of different aspects of project work to check the use of appropriate QC measures and the general function of the QA system. Field and office system assessments will be performed under the direction of the A&E's QA Director, with support from the A&E's project QA Coordinator. Quality Procedure 6.2, as defined in the A&E's QA Manual (CDM Smith 2012), defines requirements for conducting field and office system assessments. Due to the level of effort for sampling and the duration of the activities discussed in this SAP/QAPP, at a minimum, one field audit will be scheduled for GPIs annually. Office audit frequency will be in accordance with contract requirements. Laboratory system assessments/audits will be coordinated by the EPA.

C1.2 Response Actions

Corrective actions will be implemented on a case-by-case basis to address quality problems. Minor actions taken in the field to immediately correct a quality problem will be documented in the applicable field logbook and a verbal report will be provided to the A&E's Project Manager and/or Site Manager. Major corrective actions taken in the field will be approved by the USACE onsite representative, OU4 EPA RPM and A&E's Project Manager prior to implementation of the change. Major response actions are those that may affect the quality or objective of the investigation.

In addition, when modifications to this SAP/QAPP are required, either for field, SPF, or laboratory activities, the appropriate record of modification form must be completed.

C2. Reports to Management

QA reports will be provided to management for routine audits and whenever quality problems are encountered. Field staff will note any quality problems on FSDSs or in field log notes. Further, the A&E's Project Manager will inform the project QA Coordinator upon encountering quality issues that cannot be immediately corrected. Weekly reports and change request forms are not required for work performed under this SAP/QAPP.

D1. Data Review, Verification and Validation

D1.1 Data Review

Data review of project data typically occurs at the time of data reporting by the data users and includes cross-checking that sample IDs and sample dates have been reported correctly and that calculated analytical sensitivities or reported values are as expected. If discrepancies are found, the data user will contact the LC, who will then notify the appropriate entity (field, preparation facility, or laboratory) in order to correct the issue.

D2. Verification and Validation Methods

D2.1 Data Verification

Data verification includes checking that results have been transferred correctly from the original hand-written, hard copy documentation to the Scribe project database. The goal of data verification is to identify and correct data reporting errors. For data generated as part of this SAP/QAPP, data verification is the combined responsibility of each entity publishing data to Scribe (i.e., the respective Project Data Managers), as well as the LC and ERT. For analytical laboratories that utilize the Libby Asbestos Data Tool and/or project-specific Electronic Data Deliverable spreadsheets, data checking of reported analytical results begins with automated QC checks.

Data verification ensures that any data reporting issues are identified and rectified to limit any impact on overall data quality. If issues are identified during data verification, the frequency of these checks may be increased as appropriate.

It is the responsibility of the EPA Region 8 Data Manager to coordinate with the respective Project Data Managers and/or LC to resolve any project database corrections and address any recommended field or laboratory procedural changes from the data verifier. The EPA Region 8 Data Manager is also responsible for electronically tracking in the project database which data have been verified, who performed the verification, and when.

D2.2 Data Validation

Unlike data verification, where the goal is to identify and correct data reporting errors, the goal of data validation is to evaluate overall data quality and to assign data qualifiers, as appropriate, to alert data users to any potential data quality issues. Data validation will be performed by the QATS contractor (or their designate), with support from technical support staff that are familiar with project-specific data reporting, analytical methods, and investigation requirements. Data validation for GPI data collected as part of this SAP/QAPP will follow the processes and requirements established by the EPA in consultation with their QATS contractor.

D3. Reconciliation with User Requirements

Once all samples from a specific property have been collected and analytical data has been generated, data will be evaluated to determine if investigation objectives were achieved. This is typically performed by the A&E's FTL (or other designated investigation staff) whose responsibility it is ensure reported investigation results are adequate and appropriate for their intended use. To the extent possible, this data usability assessment should utilize results of any data verification and data validation efforts to provide information on overall data quality specific to each investigation.

The data usability assessment should evaluate results with regard to several data usability indicators, including precision, accuracy/ bias, representativeness, comparability, completeness, and whether specified analytic requirements (e.g., sensitivity) were achieved. **Table D-1** provides detailed information for how each of these indicators may be evaluated for the reported asbestos data. The data usability assessment results and conclusions should be included in any investigation-specific data summary reports.

Non-attainment of project requirements may result in additional sample collection or field observations in order to achieve project needs.

Table D-1: General Evaluation Methods for Assessing Asbestos Data Usability

Data Usability Indicator	General Evaluation Method
Precision	<u>Sampling</u> – Review results for co-located samples and field duplicates to provide information on variability arising from medium spatial heterogeneity and sampling and analysis methods. <u>Analysis</u> – Review results for TEM laboratory duplicates, recounts, and repreparations to provide information on variability arising from analysis methods. Review results for inter-laboratory analyses to provide information on variability and potential bias between laboratories.
Accuracy/Bias	Calculate the background filter loading rate and use results to assign detect/non-detect in basic accordance with ASTM 6620-00. For air samples, determine the frequency of indirect preparation.
Representativeness	Review relevant audit report findings and any ROMs for potential data quality issues.
Comparability	Compare the sample collection SOPs, preparation techniques, and analysis methods to previous investigations.
Completeness	Determine the percent of samples that were able to be successfully collected and analyzed (e.g., 99 of 100 samples, 99%).
Sensitivity	Determine the fraction of all analyses that stopped based on the area examined stopping rule (i.e., did not achieve the target sensitivity).

ASTM - American Society of Testing and Materials
LA - Libby Amphibole asbestos
QATS - Quality Assurance Technical Support
ROM - record of modification
SOP - standard operating procedure
TEM - transmission electron microscopy

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APPENDIX A
Detailed Data Quality Objectives (DQOs)

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Appendix A

Data Quality Objectives for General Property Investigation

The DQO process, based on scientific methods, is a series of planning steps that are designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. The DQOs presented in this section were developed in accordance with EPA guidance (EPA 2006).

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps; output from each step influences the choices that will be made later in the process. These steps include:

1. State the problem
2. Identify the decision
3. Identify the inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify tolerable limits on decision errors
7. Optimize the design

A.1 Step 1 – State the Problem

The purpose of this step is to describe the problem to be studied so that the focus of the investigation will be unambiguous.

Several property investigation field efforts have been completed for the Site, including the Phase 1 and Phase 2 investigations and the CSS. A number of properties were not inspected during these investigations due to various circumstances including refusal of access, inability to contact property owners, and incomplete county parcel information. Consequently, there are a number of properties where it is unknown whether LA contamination exists. In addition, some historical investigations were performed using techniques that differ from current site investigation protocols (e.g., 5-point composite sampling, high-traffic area visual inspections, semi-quantitative estimation of vermiculite, etc.).

This GPI SAP/QAPP was developed to reflect current investigation and sampling methods. The GPI process is divided into two distinct phases; SI and DI. SIs are intended to screen properties that have not undergone previous investigation, while DIs are performed at properties where a removal trigger has been identified. The SI and DI phases will be performed at separate times. The overall GPI sampling program described in this SAP/QAPP is designed to:

- Determine if LA and/or LA source materials are present at residential, commercial, industrial, or public properties within OU4.

- Determine the extent of LA contamination on each property if LA or LA source materials are present.

Section B.2 of this SAP/QAPP describes the sampling and inspection procedures that will be used to collect data of sufficient quality and representativeness to evaluate each of these items.

A.2 Step 2 – Identify the Decision

This step identifies what questions the investigation will attempt to resolve and what actions may result. The principal study questions and possible alternative actions are as follows:

Table A-1 Decision Statements

Response Item Evaluated	Principal Study Question	Alternative Actions
Screening Investigation		
Determine if LA or LA source materials are present on individual properties.	Is vermiculite-containing material present in buildings?	▪ Terminate SI phase and prepare for DI phase ▪ Take no action
	Is vermiculite visible in surface soils?	▪ Terminate SI phase and prepare for DI phase if vermiculite is found in SUAs ▪ For CUAs and LUAs, document location of surface soils that contain vermiculite and isolate these areas for discrete sampling ▪ Take no action
	Is LA detected at levels ≥1% in any surface soil samples collected from individual properties?	▪ Document location of LA-contaminated surface soils and prepare for DI phase ▪ Take no action
Detailed Investigation		
Determine the extent of potential LA contamination on individual properties if LA or LA source materials are present.	Is vermiculite insulation present in property buildings?	▪ Sketch and document location and extent of vermiculite for removal action ▪ Take no action
	Is vermiculite observed in building materials (e.g., plaster)?	▪ Sketch and document location and extent of LA-contaminated building materials for removal action ▪ Take no action
	Is LA detected at concentrations ≥5,000 s/cm^2 in indoor dust from any one previously collected dust sample from individual properties?	▪ Clearly note which building(s) contains the elevated dust concentration(s) on the exterior field sketch ▪ Take no action

Response Item Evaluated	Principal Study Question	Alternative Actions
	Is vermiculite visible in surface soils?	▪ Sketch and document location and extent of vermiculite-containing soil for removal action ▪ Take no action
	What is the extent of LA contamination in surface soils?	▪ Collect samples, sketch and document location and extent of LA-contaminated soil for removal action ▪ Take no action

CUA – common-use area
DI – detailed investigation
LA – Libby Amphibole asbestos
LUA – limited-use area
s/cm^2 – structures per square centimeter
SI – screening investigation
SUA – specific-use area
≥ – greater than or equal to
% – percent

A.3 Step 3 – Identify the Inputs to the Decision

The purpose of this step is to identify the information and measurements that need to be obtained to resolve the decision statements. The information needed to resolve the principal study questions are summarized in Table A-2.

A.4 Step 4 – Define the Boundaries of the Study

This step specifies the spatial and temporal boundaries of this investigation.

A.4.1 Spatial Bounds

The information gathered to answer the objectives will be collected from properties within the boundaries of OU4 and outside existing OUs as directed by the EPA (Figure B-2). The vertical spatial boundaries extend from the highest point at a property, approximately two stories, to the depth of soil samples collected, approximately 6 inches below ground surface.

A.4.2 Temporal Bounds

For each property, the temporal boundaries of this investigation include the time from when an SI begins to the time it is determined LA or LA source materials do not exist on the property or when a DI is complete.

A.5 Step 5 – Develop Decision Rules

The purpose of this step is to describe the method that the EPA will use to determine if the data collected indicate acceptance and the resulting decision applied when acceptance is not obtained. The principal study question, inputs to resolve study questions, action levels, and decision rules are summarized in Table A-3.

A.6 Step 6 – Specify Tolerable Limits on Decision Errors

The tolerable limits on decision errors, used to establish performance goals for the data collection design, are specified in this step.

Specific to performing SIs and DIs, two types of decision errors are possible:

- A Type I (false negative) decision error would occur if a risk manager decides that an inspection/sample does not contain vermiculite/LA above a level of concern, when in fact it is of concern.

- A Type II (false positive) decision error would occur if a risk manager decides that an inspection/sample does contain vermiculite/levels of LA above a level of concern, when in fact it does not.

The EPA is most concerned about guarding against the occurrence of Type I errors, since an error of this type may leave humans exposed to unacceptable levels of LA.

The EPA is also concerned with the probability of making Type II (false positive) decision errors. Although this type of decision error does not result in unacceptable human exposure, it may result in unnecessary expenditure of resources. Generally, the EPA allows for a 20 percent false positive rate.

For the purposes of completing all seven steps of the DQO process, the null hypotheses and consequences of making an incorrect decision are summarized in Table A-4. However, the gray region and tolerable limits on decision errors are not proposed because they are not applicable in this case.

Typically, Step 6 of the DQO process is useful to encourage careful design of decision rules by defining and integrating the errors that are acceptable based upon a myriad of integrated project management decisions such as reduction in risk to human health, implementability/practicability, and cost. As stated in the guidance document for development of DQOs: QA/G-4 (EPA 2006), solely statistically generated tolerable limits on decisions errors are not necessary in certain cases provided that a line of reasoning (scientific justification) is presented that adequately defines acceptable limits or decision errors. This particular effort was put forth in the *Action Level/Clearance Criteria Technical Memorandum* (EPA 2003) and the *Action Level/Clearance Criteria Technical Memorandum,* Amendment A (EPA 2011) for DQOs for the following sampling and inspection: (1) vermiculite in surface soils and property structures/buildings; (2) surface soil samples; and (3) indoor dust samples.

A.7 Step 7 – Optimize the Design for Obtaining Data

This step identifies a resource-effective data collection design for generating data that are expected to satisfy the DQOs. The data collection design is described in detail in the remaining sections of this SAP/QAPP and other site documents referenced in Section B.

Referencing the *Action Level/Clearance Criteria Technical Memorandum* (EPA 2003), *Action Level/Clearance Criteria Technical Memorandum,* Amendment A (EPA 2011) and data previously generated for the site, the DQOs have been designed to support the proposed SI and DI activities and represent the best possible project planning effort. However, in implementing the requirements contained in this SAP/QAPP, unforeseen situations may arise or team members may find more efficient means to carry out some of the day-to-day activities. Therefore, team members are always afforded the opportunity to recommend optimization of the data gathering design. Recommendations must come through proper channels (i.e., through the TL or FTL) and documented using either a Record of Modification to Documents Governing Field Activities form or an addendum to this SAP/QAPP. All modifications or addendums must be approved prior to making the proposed changes.

Table A-2 Summary of Inputs to Resolve Study Questions and Use of Information Acquired from Inputs

Principal Study Question	Input to Resolve Question	Use of Input to Resolve Question
Screening Investigation		
Is vermiculite-containing material present in buildings?	Visual Inspection	For each property undergoing an SI, attics, living spaces, walls, and understructures will be inspected for vermiculite-containing material to the extent possible. The results of the inspection will be used to determine if an LA source material is present within buildings at individual properties and result in removal action.
Is vermiculite visible in surface soils?	Visual Inspection	For each property undergoing a screening investigation, a semi-quantitative visual estimation inspection of vermiculite will be performed on surface soils throughout the entire property. The results of the visual inspection will be used to determine if LA source materials are present at individual properties and to determine if DI activities are required.
Is LA detected at levels greater than or equal to 1% in any surface soil samples collected from individual properties?	Soil Samples	For each property undergoing an SI, surface soil samples will be collected from use areas (e.g., SUAs, CUAs, LUAs, etc.). The results of the surface soil samples will be used to determine if LA contamination is present at individual properties and to determine if DI activities are required.
Detailed Investigation		
Is vermiculite insulation present in property buildings?	Visual Inspection	For each property undergoing a detailed investigation, a visual inspection will be performed within each building on the property that has not undergone an interior inspection to current protocol. The results of the visual inspection will be used to determine the extent of LA source materials for removal planning.
Is vermiculite observed in building materials (e.g., plaster)?	Visual Inspection	For each property undergoing a detailed investigation, a visual inspection of building materials will be performed within each building on the property that has not undergone an interior inspection to current protocol. The results of the visual inspection will be used to determine the extent of LA source materials for removal planning

Principal Study Question	Input to Resolve Question	Use of Input to Resolve Question
Is LA detected at concentrations greater than or equal to 5,000 s/cm^2 in indoor dust from any one previously collected dust sample from individual properties?	Dust Samples	For each property where dust samples were collected during previous investigations, analytical results will be reviewed to determine if LA contamination is present in indoor dust at individual properties for removal planning. Dust samples will not be collected as part of this investigation.
Is vermiculite visible in surface soils?	Visual Inspection	For each property undergoing a DI, semi-quantitative visual estimation inspections for vermiculite will be performed on surface soils to determine the extent of LA source materials for removal planning.
What is the extent of LA contamination in surface soils?	Soil Samples	For each property undergoing a DI, additional surface soil samples may be collected from use areas (e.g., SUAs, CUAs, LUAs, etc.) to further determine the extent of LA contamination for removal planning.

CUA – common-use area
DI – detailed investigation
LA – Libby Amphibole asbestos
LUA – limited-use area
SI – screening investigation
SUA – specific-use area

Table A-3 Decision Rules

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Screening Investigation				
Is vermiculite-containing material present in buildings?	Visual Inspection	Presence or absence of vermiculite via visual inspection	Presence of vermiculite	If open, non-contained, or migrating vermiculite is observed, the location will be documented for subsequent removal action. If contained vermiculite is observed, the location will be documented. If vermiculite is not observed, take no action.
Is vermiculite visible in surface soils?	Visual Inspection	CDM-LIBBY-06	Detectable quantities of visible vermiculite as defined in CDM-LIBBY-06	If vermiculite is observed in surface soils within SUAs, the exterior portion of the SI will terminate and preparation for a DI will begin. If vermiculite is observed in surface soils only within non-SUAs, isolate these areas for discrete sampling. If vermiculite is not observed, take no action.
Is LA detected in individual surface soil samples collected from individual properties?	Soil Samples	Analysis: PLM-VE and PLM-Grav with project-specific modifications Reported Result: % LA AS: 0.2%	Greater than or equal to1% LA	If levels of LA greater than or equal to 1% are detected in surface soil samples, the SI will terminate and preparation for a DI will begin. If levels of LA less than 1% (≤1% LA, Trace, or non-detect) are detected in surface soil samples, take no action.

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Detailed Investigation				
Is vermiculite insulation present in property buildings?	Visual Inspection	Presence or absence of vermiculite insulation via visual inspection	Presence of vermiculite	If vermiculite insulation is observed, the location will be documented for subsequent removal action. If vermiculite insulation is not observed, take no action.
Is vermiculite observed in building materials (e.g., plaster)?	Visual Inspection	Presence or absence of vermiculite insulation via visual inspection	Presence of vermiculite	If vermiculite Is observed in any friable building material, the location will be documented for subsequent removal action. If vermiculite Is observed in any non-friable building material, document location but take no action. If vermiculite is not observed in friable or non-friable building materials, take no action.
Is LA detected in indoor dust from previously collected individual dust samples from individual properties?	Dust Samples	Analysis: TEM by ASTM D5755 with project-specific modifications Reported Result: s/cm^2 AS: 1,000 per cm^2	5,000 s/cm^2	If LA is detected greater than or equal to 5,000 s/cm^2 in any dust sample, the building that the dust sample represents will be clearly identified on the exterior field sketch for subsequent removal action. If LA is detected at levels less than 5,000 s/cm^2 in any dust sample, take no action.

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Is vermiculite visible in surface soils?	Visual Inspection	CDM-LIBBY-06	Detectable quantities of visible vermiculite as defined in CDM-LIBBY-06	If vermiculite is observed in surface soils, the location will be sketched/documented for subsequent removal action. If vermiculite is not observed in surface soils, take no action.
What is the extent of LA contamination in surface soils?	Soil Samples	Analysis: PLM-VE and PLM-Grav with project-specific modifications Reported Result: % LA AS: 0.2% LA	Any detectable LA	If any detectable levels of LA are found in surface soil samples, the location will be sketched/documented for subsequent removal action. If LA is not detected in surface soil samples, take no action.

AS – analytical sensitivity
ASTM – American Society for Testing and Materials
DI – detailed investigation
LA – Libby Amphibole asbestos
NA – not applicable
ND – none detected
PLM – polarized light microscopy
s/cm^2 – structures per square centimeter
SI – screening investigation
SUA – specific-use area
TEM – transmission electron microscopy
% – percent

Table A-4 Limits on Decision Errors

Principal Study Question	Null Hypothesis	Type I Error Will Result in:	Type II Error Will Result in:
Screening Investigation			
Is open, non-contained, or migrating vermiculite containing material present in buildings?	Vermiculite is present in property buildings.	Determining that property buildings do not contain vermiculite when they actually do. This would result in no subsequent removal action and in turn, an increased risk to human health.	Determining that property buildings contain vermiculite when actually they do not. This would result in unnecessarily performing removal action planning and adds to investigation costs.
Is vermiculite visible in surface soils?	Vermiculite is present in surface soils.	Determining that surface soils do not contain vermiculite when they actually do. This may result in no subsequent exterior DI and in turn, an increased risk to human health.	Determining that surface soils contain vermiculite when they actually do not. This may result in unnecessarily performing an exterior DI and adds to investigation costs.
Is LA detected in surface soil samples collected from individual properties?	Surface soils are contaminated with LA.	Determining that surface soils are not contaminated with LA when they actually are. This may result in no subsequent exterior DI and in turn, an increased risk to human health.	Determining that surface soils are contaminated with LA when they actually are not. This would result in unnecessarily performing an exterior DI and adds to investigation costs.
Detailed Investigation			
Is vermiculite insulation present in property buildings?	Vermiculite insulation is present in property buildings.	Determining that property buildings do not contain vermiculite insulation when they actually do. This would result in no subsequent removal action and in turn, an increased risk to human health.	Determining that property buildings contain vermiculite insulation when they actually do not. This would result in unnecessarily performing removal action planning and adds to investigation costs.

Principal Study Question	Null Hypothesis	Type I Error Will Result in:	Type II Error Will Result in:
Is vermiculite observed in friable building materials (e.g., plaster)?	Friable building materials contain vermiculite.	Determining that friable building materials do not contain vermiculite when they actually do. This would result in no subsequent removal action and in turn, an increased risk to human health.	Determining that friable building materials contain vermiculite when they actually do not. This would result in unnecessarily including the building materials in the removal action and adds unnecessary costs to the investigation and removal.
Is LA detected in indoor dust from previously collected dust samples?	Indoor dust is contaminated with LA.	Determining that indoor dust is not contaminated with LA when it actually is. The LA-contaminated living space would not be included in the removal action and in turn, pose an increased risk to human health.	Determining that indoor dust that contains is contaminated with LA when it actually is not. This would result in unnecessarily including an interior cleaning in the removal action and adds unnecessary costs to the investigation and removal.
Is vermiculite visible in surface soils?	Vermiculite is present in surface soils.	Determining that surface soils do not contain vermiculite when they actually do. The vermiculite containing soils would not be included in the removal action and in turn, pose an increased risk to human health.	Determining that surface soils contain vermiculite when they actually do not. This would result in unnecessarily including exterior excavation in the removal action and adds unnecessary costs to the investigation and removal.
What is the extent of LA contamination in surface soils?	Surface soils are contaminated with LA.	Determining that surface soils are not contaminated with LA when they actually are. The LA-contaminated soils would not be included in the removal action and in turn, pose an increased risk to human health.	Determining that surface soils are contaminated with LA when they actually are not. This would result in unnecessarily including exterior excavation in the removal action and adds unnecessary costs to the investigation and removal.

DI – detailed investigation
LA – Libby Amphibole asbestos

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APPENDIX B
Standard Operating Procedures (SOPs)

Panel A: Field SOPs

SOP ID	SOP Description
EPA-LIBBY-2012-01	Field Logbook Content and Control
EPA-LIBBY-2012-02	Photographic Documentation of Field Activities
EPA-LIBBY-2012-03	Control of Measurement and Test Equipment
EPA-LIBBY-2012-04	Field Equipment Decontamination
EPA-LIBBY-2012-05	Handling Investigation-derived Waste
EPA-LIBBY-2012-06	Sample Custody
EPA-LIBBY-2012-07	Packaging and Shipping Environmental Samples
CDM-LIBBY-03	Completion of Field Sample Data Sheets
CDM-LIBBY-05	Soil Sample Collection at Residential and Commercial Properties
CDM-LIBBY-06	Semi-Quantitative Visual Estimation of Vermiculite in Soils at Residential and Commercial Properties
CDM-LIBBY-09	GPS Coordinate Collection and File Transfer Process
CDM-LIBBY-17	Crawlspace Entry

Panel B: Laboratory SOPs

SOP ID	SOP Description
ISSI-LIBBY-01	Soil Sample Preparation
EPA-LIBBY-08	Indirect Preparation of Samples for TEM Analysis
SRC-LIBBY-01	Analysis of Asbestos in Soil by PLM-Grav
SRC-LIBBY-03	Analysis of Asbestos in Soil by PLM-VE
SRC-LIBBY-05	Collection and Analysis of Asbestos in Indoor Dust

Libby Asbestos Superfund Site
Standard Operating Procedure
Field Logbook Content and Control

Prepared by: ______________________ Date: 7/23/12
CDM Smith

Approved by: ______________________ Date: 7/23/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--
1	7/23/12	To maintain consistency with requirements for completing other field documentation (e.g., field sample data sheets), eliminated the requirement to strike through, initial, and date any self-adhesive labels placed in the logbook.

1.0 Objective

Logbooks are an essential tool to document field activities conducted by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the content and control of Libby Site field logbooks. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Ruler or similar scale – Used with a property-specific drawing or plan to measure distance and sizes of objects, buildings, and zones.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

2.2 Discussion

Field logbooks are an accounting of observations and/or activities occurring at or associated with the Libby Site. Field logbooks are also used to duly document changes to or deviations from governing documents referencing this SOP. Information recorded in field logbooks includes date/time, site personnel, observations, calculations, weather, locations of field activities, and a description of the field activity, methods, instruments, and results. Additionally, the logbook may contain descriptions of waste, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for documenting activities in field logbooks will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for ensuring that the format and content of data entries are in accordance with this procedure. It is also the responsibility of the TL to communicate the need for any changes to/deviations from the SOP with the appropriate personnel, and document the change/deviation using a Libby Field Record of Modification Form.

Field Team Members – Field team members who make entries in field logbooks are required to read this procedure before engaging in this activity. Field team members will be assigned a field logbook prior to field activities and will be responsible for the care and maintenance of the logbook. Field team members will return field logbooks to the project file at the end of the assignment.

4.0 Equipment

The following is required for the proper completion of field logbooks:

- Logbook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 Procedures

5.1 Preparation

Commercially available, bound field logbooks with waterproof paper and lined, consecutively numbered pages will be used. Separate field logbooks will be kept for each field activity and the cover (some items may be recorded on the inside cover) of each field logbook shall clearly indicate:

- Field logbook sequence number
- Start date and end date of entries
- Title of document governing field activities
- Activity (if the logbook is to be activity-specific), site name, and location
- Contact name and phone number (typically the Project Manager)

For ongoing field activities that may span months or years, designated staff (e.g., field administrative staff) shall manage the field logbooks by tracking to whom and the date each field logbook was assigned, the general activities recorded in each field logbook, and the date the field logbook was returned to the project file.

The first two pages of the logbook will be reserved for a table of contents (TOC), and the third page will be reserved for abbreviations, acronyms, and definitions.

5.2 Operation

The following general requirements will apply when completing logbook entries for the Libby Site:

- Record equipment calibrations, work, observations, and quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are required by the governing document referencing this SOP, the information collected on the form does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Correct erroneous information recorded in a field logbook with a single line strikeout, initial, and date. The correct information will be entered in close proximity to the erroneous entry.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not remove any pages from the logbook.
- Document relinquishment of the logbook from one author to another (both parties must sign and date the transfer).
- Sign and date the final entry each day.
- When columns are used to organize information recorded on laboratory documents, the information recorded in the columns shall be identified in a column heading.

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each location where a sample is collected or an observation or measurement made, a detailed description of the location is required and a sketch of the location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Any maps, sketches, figures, or data that will not fit on a logbook page, or any separate forms or drawings (e.g., FSDS sheets, drawing markups) required by the governing document referencing this SOP should be referenced in the logbook.

Other events and observations that should be recorded include:

- Changes in weather or site conditions that impact field activities or have the potential to impact data collection (e.g., rain impacting air samples, upwind disturbances)
- Deviations from procedures outlined in any governing documents referencing this SOP, including the rationale and authorization for the deviation as appropriate
- Problems, downtime, or delays
- Visitors to the site

5.3 Post-operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages and any supporting attachments shall be periodically photocopied (weekly, at a minimum) and maintained in the project file.

At the conclusion of each field activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated, that corrections were made properly, and that the cover information and TOC are complete. As field logbooks are completed, electronic copies may need to be posted to a project eRoom – refer to the governing document referencing this SOP for requirements. All original logbooks will be catalogued and maintained in the project file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by governing agency personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not intended for personal use.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure consistency in recording information in field logbooks for Libby Site activities. Consistency will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require re-training of the field team members.

7.2 Field Checks

Field logbooks may be checked for completeness and adherence to SOP requirements on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any errors noticed during the checks will be discussed with the author and corrected. If field activities continue beyond six months, the frequency of assessing field logbook entries will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-1, Field Logbook Content and Control, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Photographic Documentation of Field Activities

Prepared by: ______________________ Date: 4/12/12
CDM Smith

Approved by: ______________________ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Photographic documentation, which includes still and digital photography and videotape or digital versatile/video disc (DVD) recordings, is an essential tool to document field activities conducted by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for photographic documentation. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Arrows and Pointers – Used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds – Backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back – A camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film. Digital cameras and recorders may also be equipped with a date stamping feature.

Identifier Component – Visual components used within a photograph such as visual slates, reference markers, and pointers.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Photographer – The camera operator (professional or amateur) for still photography, including digital photography, or videotape or DVD recording, whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Reference Marker – A reference marker used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

Slates – Blank white index cards, paper, or a dry-erase board used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

2.2 Discussion

Photographs and videotape or DVD recordings made during field activities are used as an aid in documenting and describing site features, sample collection activities, equipment used, and conditions during the field activity being performed. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, videotape recordings (or video footage), and recordings on DVDs. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for photographic documentation will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The TL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer – The photographer shall seek direction from the TL and regularly discuss the visual documentation requirements and schedule. The photographer may be responsible for maintaining a logbook or itemization of photos/recordings or providing captions. Specific requirements will be defined in the governing document referencing this SOP.

4.0 Equipment

The following equipment may be used for photographic documentation:

- 35-millimeter (mm) camera and appropriate film (e.g., medium speed or multi-purpose fine-grain color)
- Disposable, single-use camera (35mm or panoramic use)
- Digital camera
- Video camera and appropriate storage media (e.g., videotapes, DVDs)
- Extra batteries
- Standard reference markers
- Slates

- Arrows or pointers
- Contrasting backgrounds
- Logbook
- Data recording camera back (if available)
- Indelible black or blue ink pen
- Storage medium for digital camera

5.0 Procedures

5.1 Preparation

In addition to this SOP, photographers must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety (including requirements for personal protective equipment at a site), sample collection, equipment and personnel decontamination, documentation, etc. These procedures should be maintained on site by field staff at all times for easy reference.

The photographer should also be aware of any potential physical hazards while photographing the subject (e.g., traffic, operating equipment, low overhead hazard, edge of excavation area).

If required, a commercially available, bound logbook will be used to log and document photographic activities. Alternatively, a portion of the field logbook may be designated as the photographic log and documentation section.

Because digital cameras and DVD recorders have multiple photographic quality settings, if not specified in the governing document referencing this SOP, the TL shall specify the resolution (quality) at which photographic documentation should be collected. It should be noted that a camera or DVD recorder that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2 Operation

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Slate and caption information will not be required at the Libby Site unless specified in the governing document referencing this SOP.

5.2.1 Still Photography

Slate Information

Each new roll of film or digital storage medium will contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a unique, consecutive number that is assigned by the photographer).

Caption Information

Still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. Digital photographs should have a caption added after the photographs are downloaded. Unless modified by the governing document referencing this SOP, captions should contain the following information:

- Film roll control number (if required) and photograph sequence number
- Site name or location

- Description of activity/item shown
- Date and time
- Direction (if applicable)
- Photographer

Close-up and Feature Photography

Close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their *in situ* locations to enable a more accurate record of their initial condition and color for formal lithologic observations and interpretations.

Site Photography

Site photography, in general, consists predominantly of medium- and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane. While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the logbook (field or photographic), photographic caption, or digital file name shall specify all information pertinent to the scene.

5.2.2 Photographic Documentation Using Video Cameras

As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or “show” videotape or DVD recording. The following guidelines are set for documentary videotape or DVD recordings only and should be implemented at the discretion of the site personnel.

Documentary videotape or DVD recordings of field activities may include an audio slate for all scenes, as directed by the governing document referencing this SOP. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

A standard reference marker and caption/slate may be included in all scenes, as directed by the governing document referencing this SOP. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A label should be placed on the videotape or DVD with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.3 Photographic Logs

Photographic activities shall be documented in a photographic log or in a section of the field logbook, as directed by the governing document referencing this SOP. The photographer will be responsible for making proper entries.

The following information shall be maintained in the appropriate logbook:

- Photographer name
- Roll/tape/DVD control number (as appropriate)
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used)
- Date and time (military time)
- Location
- Description of the activity/item photographed
- Description of the general setup, including approximate distance between the camera and the subject
- Other pertinent information to assist in the identification of the subject matter

5.3 Post-operation

5.3.1 Processing

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer will also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape or DVD to the TL to be placed in the project file.

Digital media should be downloaded daily to a personal computer or secure server; the files should be in either “JPEG” or “TIFF” format. Files should be renamed at the time of download in accordance with any file-naming conventions required by the governing document referencing this SOP, or to correspond to the logbook. At a minimum, the file name should include the corresponding sampling location and/or sample number and the photograph date (e.g., “123 Elm St_2-15-2011”, “AA-12345_3-18-2009”).

5.3.2 Documentation

At the end of each day’s photographic session, the photographer(s) will ensure that all photographic documentation has been maintained in accordance with this SOP.

5.3.2 Archive

Unless otherwise specified in Libby Site data management requirements or the governing document referencing this SOP, digital photographs will be stored on a secure server (with a nightly backup) or posted to a web-based location (e.g., an eRoom or SharePoint portal). These files will be archived until project closeout, at which time project management will determine a long-term electronic file storage system.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field personnel to ensure that an effective and standardized program of visual documentation is maintained.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the TL.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure quality photographic documentation is gathered to support site activities. Consistency will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require re-training of the field team members.

7.2 Field Checks

Photographic documentation processes may be checked for completeness and adherence to SOP requirements on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any errors noticed during the checks will be discussed with the photographer and corrected. If field activities continue beyond six months, the frequency of assessing photographic documentation will be established by the Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-2, Photographic Documentation of Field Activities, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Control of Measurement and Test Equipment

Prepared by: Terry Crowell Date: 4/12/12
CDM Smith

Approved by: Dania Zinner Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the control of measurement and test equipment (M&TE) used by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Traceability – The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures, and in accordance with any other related requirements specified in the governing document referencing this SOP.

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE is responsible for being knowledgeable of, and understanding and implementing the requirements contained herein, as well as any additional related requirements.

Team Leader (TL) – Responsible for identifying the technical specifications (e.g., precision, accuracy) for M&TE needed to meet project data collection objectives, and determining any additional applicable Libby Site-specific requirements (e.g., periodic calibration of primary calibration sources) for M&TE.

Requisitioner – Responsible for ensuring M&TE is obtained or procured that meets the technical specifications identified by the TL, and facilitates obtaining the manufacturer's operations and maintenance and calibration procedures prior to field work.

Receiver – Responsible for receipt and/or unpackaging of M&TE and notifying the TL that the item has been received.

User – Responsible for the proper preparation and use of M&TE to collect the quality and quantity of data needed to meet project objectives. Users are typically field team members.

4.0 Equipment

Required M&TE will be specified in the governing document referencing this SOP.

5.0 Procedures

The following general requirements apply to M&TE at the Libby Site. Additional details and responsibilities are described later in this section.

- Manufacturer maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an equipment or field log according to requirements stated in the governing document referencing this SOP
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.1 Preparation

5.1.1 Obtain the Operating, Maintenance, and Calibration Documents

For Procured M&TE

Requisitioner – Specify that the maintenance and calibration procedures be included.

For GF M&TE Acquired as a Result of Property Transfer

TL – Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, obtain the appropriate documentation from the manufacturer.

For Rented or Leased M&TE

Requisitioner – Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, request it from the vendor.

5.1.2 Prepare and Record Maintenance and Calibration Records

For All M&TE

Receiver – Upon receipt of an item of M&TE, notify the TL for the overall property control of the equipment.

TL and User – Record all maintenance and calibration events in an equipment or field log. The log must have sequentially-numbered pages.

5.2 Operation

TL and User – Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.2.2 Traceability of Calibration Standards

For All M&TE

TL and User –

- When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
- Require certifications for standards that clearly state the traceability.
- Require Material Safety Data Sheets to be provided with standards.
- Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.2.3 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:

User – Immediately discontinue use and segregate the item from other equipment.

TL – Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate authorities (typically the Project Manager) of the results. Any test results that are known to impact or have the potential to impact project data will be documented using a Libby Field Record of Modification Form.

5.3 Post-operation

M&TE shall be promptly returned to the owner at the end of field activities. All operations, maintenance, and calibration procedures shall be retained with the M&TE. Project M&TE records (e.g., equipment logs) will be retained in the project file.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the Health and Safety Manager and/or Quality Assurance Manager. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes. Every effort will be made to ensure the appropriate and functional M&TE are used to support site activities. This will be achieved to the extent possible through proper training, use of qualified procurement and designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require discussion with appropriate management and, as appropriate, re-training of the field team members. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 5-1, Control of Measurement and Test Equipment, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Field Equipment Decontamination

Prepared by: ____________________ Date: 4/12/12
CDM Smith

Approved by: ____________________ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site. The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the decontamination of field equipment used by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Definitions

Clean – Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross contamination – The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination – The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

De-mineralized water – Water that has had most to all minerals removed from it. De-mineralized water shall only be stored in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Material Safety Data Sheet (MSDS) – Document that discusses the proper storage and physical and toxicological characteristics of a particular substance used during field operations. MSDSs are to be maintained on site at all times during field operations.

Potable water – Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling equipment – Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and trowels or bowls used to collect and/or homogenize samples.

Soap – Low-sudsing, non-phosphate detergent (e.g., Liquinox®).

Solvent rinse – Pesticide-grade (or better) isopropanol, acetone, or methanol.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for field equipment decontamination will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader - The TL is responsible for ensuring that field personnel are properly trained and that decontamination is conducted in accordance with this procedure and any other pertinent Libby Site decontamination processes cited in the governing document referencing this SOP.

Field Team Members – Field team members performing operations on the Libby Site are responsible for adhering to the procedures contained in this SOP and any other decontamination processes specified in the governing document referencing this SOP. If required, field team members will collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented. Field team members are also responsible for communicating any problems pertaining to the decontamination of field equipment to the TL.

4.0 Equipment

The following equipment may be employed wholly or in part during use of this SOP (refer to the governing document referencing this SOP for detailed requirements):

- Stiff-bristle scrub brushes
- Plastic buckets, scoops, trowels, and troughs
- Soap
- Nalgene® or Teflon® sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayers (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water (potable water may be required to be tested for contaminants before use)
- De-mineralized water
- Gloves, safety glasses, and other protective clothing as specified in the health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source

- Tools for equipment assembly and disassembly
- 55-gallon drums or tanks for temporary storage of decontamination water
- Pallets for drums or tanks holding decontamination water

5.0 Procedures

All reusable equipment (non-dedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sample media or personnel using the equipment. Decontamination of equipment shall occur either at a specified location, central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally-located decontamination area may include an appropriately-sized bermed and lined area on which equipment decontamination occurs and equipped with a collection system and/or storage vessels. In certain circumstances, berming may not be necessary when small quantities of water are being generated and for some short duration field activities. Equipment shall be transported to and from the decontamination area in a manner to prevent cross contamination of equipment and/or the area.

Typically at the Libby Site, decontamination water will not be captured and will be discharged to the ground at the site. However, the exact procedure for decontamination waste disposal may be discussed in the governing document referencing this SOP. Also, solvent rinse fluids may need to be segregated from other investigation-derived waste (IDW).

All items that come into contact with potentially contaminated media shall be decontaminated before use, between sampling locations (does not need to be performed between aliquots of an individual sample) and/or drilling locations, and after use. All decontamination procedures for the equipment being used are provided in the following sections.

General Guidelines

- Potable or de-mineralized water shall be free of all contaminants of concern. Depending upon the governing document referencing this SOP, analytical data from the water source may be required to ensure it is clean.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or Libby Site-specific requirements regarding solvent use shall be stated in the governing document referencing this SOP.
- All solvents[1] shall be pesticide-grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate field logbook.
- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all equipment, including type of equipment, date, time, method of decontamination, and any associated field quality control sampling, shall be recorded in the field logbook.

[1]Solvents are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the investigation-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the governing document referencing this SOP and/or health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment typically used at the Libby Site includes drilling rigs, trucks, and excavators. For any heavy equipment used during EPA response actions, the equipment decontamination procedures provided in the current version of the Libby Asbestos Site Response Action Work Plan shall apply. For all other field activities, follow these steps when decontaminating heavy equipment:

1. Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the investigation area(s).
2. With the heavy equipment in place, spray areas (rear of rig or backhoe) exposed to contaminated media by pressurized means. Be sure to spray down all surfaces, including the undercarriage.
3. Use brushes, soap, and appropriate decontamination water to remove dirt whenever necessary.
4. Remove equipment from the decontamination pad.
5. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, and stems. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
2. Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination areas shall be upwind of any areas under investigation.
3. Using soap and appropriate water with pressurization (e.g., Hudson® sprayer), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
4. If using soapy water, rinse the equipment using clean appropriate water with pressurization.
5. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
6. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing

contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

1. Set up a decontamination line. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment.
2. Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
3. Wash the items with appropriate water and soap using a stiff brush as necessary to remove particulate matter and surface films. With the exception of polyvinyl chloride or plastic items, the items may be steam-cleaned using soap and hot water as an alternative to brushing. Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
4. Thoroughly rinse the items with potable water.
5. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using de-mineralized water. The specific chemicals used for the solvent rinse phase shall be specified in the work plan. Solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health effects. Appropriate personal protective equipment (PPE) must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping solvent chemicals.
6. Rinse the items thoroughly using de-mineralized water.
7. Allow the items to air dry completely.
8. After decontamination activities are completed, collect all plastic sheeting, and disposable PPE. Place the contaminated items in properly labeled bags or containers for disposal. Refer to the governing document referencing this SOP for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

1. Set up the decontamination area and separate “clean” storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up three containers: the first container shall contain dilute (non-foaming) soapy water; the second container shall contain potable water; and the third container shall contain de-mineralized water.
2. The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Pump soapy water through the pump assembly. Scrub the outside of the pump and other wetted parts with a metal brush.

3. Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
4. Move the pump intake to the de-mineralized water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
5. Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered to prevent the entry of airborne contaminants and particles.

5.5 Instrument Probe Decontamination

Instrument probes used for field measurements (e.g., pH meters, conductivity meters) shall be decontaminated between samples and after use with de-mineralized water. At no time shall a sample probe be placed in contact with water within a sample container.

5.6 Waste Disposal

Waste disposal should follow the requirements listed in Libby project-specific SOP for handling investigation-derived waste (IDW) and the governing document referencing this SOP. The following are guidelines for disposing of waste:

- Decontamination water will typically not be captured, packaged, labeled, or stored as IDW at the site. Decontamination water will be discharged to the ground at the work site. Other materials used in the decontamination process will be disposed of as IDW.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be segregated in separate containers.
- Plastic sheeting and disposable protective clothing will be treated and disposed of as asbestos-containing materials.

6.0 Restrictions/Limitations

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with EPA Region 8 and the State of Montana for approved decontamination solvents.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper field equipment decontamination, which will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Adherence to field equipment decontamination requirements may be checked on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any non-compliance discussed with the field team member. If field activities continue beyond six months, the frequency of assessing field equipment decontamination will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-5, Field Equipment Decontamination, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Handling Investigation-derived Waste

Prepared by: ______________________ Date: 4/12/12
CDM Smith

Approved by: ______________________ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for handling investigation-derived waste (IDW) resulting from work performed by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Hazardous Waste – Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-derived Waste (IDW) – Discarded materials resulting from field activities such as sampling, surveying, drilling, excavation, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

Treatment, Storage, and Disposal Facility (TSDF) – Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the EPA and appropriate state and local agencies.

2.2 Discussion

At the Libby Site, field investigation and response action activities may result in the generation of IDW. IDW may include soil and cuttings from test pits or well installation; soil and other materials from the collection of samples; personal protective equipment (PPE); and other wastes or supplies used during the sampling and testing of potentially hazardous materials.

The vast majority of Libby Site IDW is expected to relate to the contaminant of concern – Libby amphibole asbestos. The overall management of IDW must comply with applicable regulatory requirements.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for handling IDW will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for identifying Libby Site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements, and ensuring that all IDW procedures are conducted in accordance with this SOP. The TL will communicate with the field team members regarding the specific objectives and anticipated situations that require deviation from this SOP.

Field Team Members – Field team members are responsible for adhering to the procedures contained in this SOP, and communicating any unusual or unplanned condition to the TL.

4.0 Equipment

Equipment required for IDW containment may vary according to field activity requirements. Management decisions concerning the necessary equipment required shall consider containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (e.g., bags, drums, tanks, etc.) and the ultimate disposition of the IDW shall be specified in the governing document referencing this SOP. Typical IDW containment devices include:

- Plastic sheeting (polyethylene) with a minimum thickness of 6 mil
- U.S. Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

The volume of the appropriate containment device shall be specified in the governing document referencing this SOP.

4.2 IDW Container Labeling

A “Waste Container” or “IDW Container” label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are as detailed below.

- Labels and markings must contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents.

- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.

- Containers that are 5 gallons or less may only require one label or set of markings.

- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.

- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the container color.

- Labels will be secured in a manner to ensure that they remain affixed to the container.

Labeling or marking requirements for IDW expected to be transported off of the work site must be in accordance with the requirements of 29 CFR 1926.1101.

4.3 IDW Container Movement

Staging areas for IDW containers shall be predetermined and in accordance with investigation-specific requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation of IDW containers offsite via a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW awaiting results of pending chemical analysis or further onsite treatment shall be staged on site. Staging areas and bulk storage procedures are to be determined according to investigation-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage (e.g., steel drums shall not be stored in direct contact with the ground).

5.0 Procedures

The three general options for managing IDW are: 1) collection and onsite disposal; 2) collection for offsite disposal; and 3) collection and interim management. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the Libby Site remedy

5.1 Collection and Onsite Disposal

5.1.1 Soil/Sludge/Sediment

Unless otherwise specified in the governing document referencing this SOP, when handling soil/sludge/sediment IDW at the Libby Site, the following will apply:

- Return IDW to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (i.e., the contaminated soil will not be in a different area or at a different depth than from where it was originally obtained).

5.1.2 Aqueous Liquids

Unless otherwise specified in the governing document referencing this SOP, options for handling aqueous liquid IDW at the Libby Site are listed below. These options may require results of laboratory analysis to obtain client and/or regulatory approval.

- Discharge to ground surface close to the well from which it was extracted, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background up-gradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.
- When small amounts (i.e., less than 5 gallons) of used decontamination fluids are generated during site characterization activities (e.g., during soil sampling), the fluids may be discharged to the ground surface within the sampling area or allowed to evaporate from an open bucket.

5.1.3 Disposable PPE

Disposable PPE IDW (not including excess soil volume) for the Libby Site will be collected in garbage bags and marked “IDW” with an indelible ink marker. These bags will be deposited into the asbestos-containing material (ACM) waste stream for appropriate disposal at the local Class IV asbestos landfill. Excess soil volume will be returned to the area from where it was collected.

5.2 Collection and Interim Management

Collection and interim management options that may be employed for Libby Site IDW are provided herein.

Storing IDW onsite until the final action may be practical in the following situations:

- Returning wastes (especially sludges and soils) to their onsite source area would require re-excavation for disposal as determined for the final site remedy.
- Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
- Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
- Interim storage may be necessary to provide time for sampling and analysis.

6.0 Restrictions/Limitations

Managers of the site shall determine the most appropriate disposal option for IDW an activity-specific basis. Parameters to consider, especially when determining the level of protection, include: the volume of IDW and the nature of contaminants present in the site soil. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components and therefore may need to be handled, treated, and disposed as non-liquid waste. Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. Under no circumstances shall these types of materials be stored in a site office, facility, or warehouse.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper handling of IDW, which will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Adherence to requirements for handling IDW may be checked on a daily basis by the TL (or their designate) for the first week of each field activity. These checks can be extended to once per month as field activities continue. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require field team member re-training. If field activities continue beyond six months, the frequency of assessing field logbook entries will be established by the field Quality Assurance Manager or their designate.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 2-2, Guide to Handling Investigation-derived Waste, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Sample Custody

Prepared by: Terry Crowell
CDM Smith
Date: 4/12/12

Approved by: Dania Zinner
EPA Region 8
Date: 4/12/12

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Sample custody procedures are integral to maintaining and documenting the possession of environmental samples collected by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for sample custody for the Libby Site. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Chain-of-custody record (COC) – Used to document the custody, control, transfer, analysis, and disposition of samples.

Custody seal – An adhesive-backed seal that is applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

Facility – A designated sample processing facility, analytical laboratory, or long-term storage area, for Libby Site samples.

Field sample data sheet (FSDS) – A controlled document used to record sample information.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Sample – Material to be analyzed that is contained in single or multiple containers representing a unique sample number.

Sample custody – The possession or safe-keeping of samples in such a manner that prevents tampering, damage, or loss.

Sample labels – Adhesive-backed labels that contain, at a minimum, the unique sample number/identifier. Sample labels are typically used on field documentation, sample cassettes, and containers, and may be pre-printed to minimize sequencing or transcription errors.

2.2 Discussion

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures must be followed.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for the custody of samples will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

<u>Team Leader (TL)</u> – Responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events.

<u>Sampler</u> – Responsible for the care and custody of samples from the time of collection until they are transferred.

<u>Field Sample Coordinator (FSC)</u> – Responsible for accepting samples into their custody from the sampler(s), producing COCs, and relinquishing or shipping samples to the appropriate facility.

<u>Laboratory Coordinator (LC)</u> – Responsible for coordinating the preparation and/or analysis of Libby Site samples with project facilities in order to achieve requested turnaround times for analytical data.

4.0 Equipment

Depending upon staff responsibility, the following equipment will be employed during use of this SOP:

- Field logbook
- FSDSs
- Indelible blue or black ink pens
- Sample labels
- Zip-top plastic bags
- Custody seals
- Container(s) in which to keep/protect samples

5.0 Procedures

5.1 Preparation

Communications between the TL, sampler(s), the FSC, the LC are critical to ensure the efficient throughput of samples to meet project data objectives. As such, an FSC will attend all field planning meetings to gather information about sampling events (e.g., sample quantities, special sample handling, processing, or analysis concerns, and requested turnaround times). For long-term field programs, sampling staff will notify the FSC daily of the estimated number and type of samples to be collected. In either case, the FSC will relay the pertinent investigation-specific information to the LC, who will, in turn, coordinate preparation and/or analysis with project facilities. On an as-needed basis (typically daily during the field season), the FSC will schedule meetings in which to relinquish samples to the LC.

5.2 Operation

A sample is under custody if it is: 1) in your possession, 2) in your view after being in your possession, 3) in your possession and you locked it up, or 4) in a designated secure area. The following procedures detail the process used to maintain the custody of each Libby Site sample. Note that if at any point samples are left unattended or receipt of samples is refused, this must be documented in the field logbook or on the COC, as appropriate.

5.2.1 Sampler Custody

Sample custody begins at the time of sample collection and will be maintained using a field logbook and FSDSs to document pertinent sample-related information. Samples will be placed in safe areas where they are protected from tampering, damage, or loss. Following sample collection, custody seals will be used as an indicator of tampering. Samples will remain in the sampler's possession, within sight, or in a secure area (e.g., locked vehicle) until the sample is relinquished.

For samples collected using zip-top bags as the primary container, all samples will be double-bagged and custody sealed on the outer bag by the sampler. For samples collected using cassettes, the cassette will be custody sealed so that both end caps of the sampling cassette are covered but sample labels or identifiers are not obstructed. The cassette will then be placed in a zip-top bag.

Sampler(s) may be required to transfer custody of samples directly to an FSC or a designated secure sample storage location, or to hand deliver or ship samples to a facility – refer to the governing document referencing this SOP for specifics. Project-specific SOP EPA-LIBBY-2012-07, *Packaging and Shipping Environmental Samples*, will be followed for samples that are required to be shipped.

If relinquishing to an FSC or secure storage area, the sampler will note in the field logbook the time of transfer, and the name and company affiliation of the receiver or dedicated storage location. Completed and quality-checked FSDSs will accompany the samples.

5.2.2 FSC Custody

Upon receipt of samples and accompany FSDSs, the FSC will verify that:

- Each FSDS is complete
- Each sample is accounted for
- Soil samples are double-bagged
- Each cassette is sealed in its own zip-top bag and caps on cassettes are in place
- Sample containers (e.g., bags, bottles) are tightly sealed
- Custody seals are correctly and securely placed on each sample
- Samples appear to be in an acceptable condition (i.e., cassettes are not cracked; sample containers are not leaking, etc.).
- No information is provided on the sample or sample container that would disclose the origin of the sample to the facility

The FSC will immediately contact the sampler if any acceptance issues are encountered. Once accepted, the FSC will prepare a COC using EPA-specified data management tools (e.g., Data Entry Tool, Scribe). An investigation-specific Analytical Summary Sheet (available in the SAP or Libby Field eRoom) will be attached to the COC. The FSC will group or batch the appropriate number of individual samples on a COC to facilitate data reporting, or as otherwise requested by the LC.

The following general batching guidelines will be used for commonly sampled Libby Site media:

- 10 or fewer non-clearance air samples on one COC
- one set of five clearance air samples and two corresponding field blanks on one COC
- 20 or fewer soil or soil-like (e.g., duff, wood chip) samples on one COC
- 10 or fewer dust samples on one COC

Following coordination with the LC, the FSC will hand deliver or ship samples (following project-specific SOP EPA-LIBBY-2012-07, *Packaging and Shipping Environmental Samples*) to the designated facility. All samples will be maintained in a secure location by the FSC until they are relinquished to another party.

5.3 Post-operation

Sample documentation (logbooks, FSDSs, field copy of the COC, etc.) will be maintained in accordance with Libby Site data management requirements and any special requirements stated in the governing document referencing this SOP (e.g., posting to an eRoom).

6.0 Restrictions/Limitations

For EPA Contract Laboratory Program sampling events, combined chain-of-custody/traffic report forms generated with Scribe or other EPA-specific records may be used. Refer to EPA regional guidelines for completing these forms. Scribe software may be used to customize sample labels and custody records when directed by the client.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper sample custody from the point of collection to final disposition. Sample custody will be maintained to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Field checks for adherence to this SOP may be performed on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue. Any non-compliance issues will be discussed with field personnel and corrected. If field activities continue beyond six months, the frequency of assessing sample custody procedures will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 1-2, Sample Custody, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Packaging and Shipping Environmental Samples

Prepared by: Terry Crowell Date: 4/12/12
CDM Smith

Approved by: Dania Zinner Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the packaging and shipping of environmental samples collected by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Sections 2.0 through 7.0 of this SOP outline requirements for the packaging and shipping of regulated environmental samples under the U.S. Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations (for shipment by air) and applies only to domestic shipments.

This SOP does not cover the requirements for packaging and shipment of equipment or bulk chemicals that are regulated under the DOT, IATA, and ICAO, nor does it address shipment of hazardous materials. Hazardous material will not be shipped unless personnel have received training that meets the requirements of the governing agency and the DOT.

Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

<u>Bottle ware</u> – Plastic or glass bottles or jars used to contain sampled material. Their purpose is to keep sampled material from mixing with the ambient environment.

<u>Chain-of-custody record (COC)</u> – Used to document the custody, control, transfer, analysis, and disposition of samples.

<u>Custody seal</u> – An adhesive-backed seal that is applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

<u>Environmental sample</u> – An aliquot of air, water, plant material, sediment, or soil that represents potential contaminant levels at a site. This procedure applies only to environmental samples that

contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Facility – A sample processing facility, analytical laboratory, or long-term storage area that serves as the receiver for Libby Site samples.

Excepted quantity – Excepted quantities are limits to the mass or volume of a hazardous material in the sample containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Limited quantity – Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance testing – Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

2.2 Discussion

Proper packaging and shipping is necessary to ensure the integrity of environmental samples during transport. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both the governing agency and the individual employee at risk of serious fines.

3.0 Responsibilities

Successful execution of this SOP requires a clear definition of assigned roles and responsibilities. All staff responsible for packaging or shipping Libby Site environmental samples will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – Responsible for overseeing sample packaging and shipping processes as described in this SOP.

Packager/Shipper – Party (typically the Field Sample Coordinator or Sampler) responsible for properly packaging and shipping samples to the designated project facility.

Qualified Shipper – Responsible for ensuring that samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT, and for determining the amount of preservative in each sample so that accurate determination of quantities can be made.

4.0 Equipment

4.1 Environmental Samples without Preservatives

The following equipment will be used when packaging and shipping Libby Site samples:

- Shipping containers (e.g., insulated cooler for limited quantities, a sturdy box for air samples)
- Bubble wrap or other space filler
- Heavy-duty plastic garbage bags
- Plastic zip-top bags
- Custody seals
- Clear packaging tape
- Completed chain-of-custody record
- Duct tape
- Completed shipping label
- Completed return address label (for return of coolers)

Vermiculite, shredded paper, expanded polystyrene, or other absorbent material will not be used for packaging or shipping Libby Site samples. Plastic bubble wrap and ice (as required) is acceptable packing material.

4.2 Environmental Samples with Preservatives

In addition to the equipment listed in Section 4.1, the following additional equipment is required when packaging samples containing preservatives:

- Sample containers
- Insulated coolers
- ice packs/bags or “blue ice”
- Sample labels
- Nitrile gloves

5.0 Procedures

5.1.1 Preparation

Considerations that must be made prior to shipping samples include selecting the appropriate shipping option (e.g., overnight delivery) so that analytical holding times for the samples are not exceeded; packaging samples in time to meet courier or shipping service pick-up times; and making arrangements with the project facility regarding Saturday receipt of samples.

5.2 Operation

5.2.1 Solid Media Samples without Preservatives

The following processes will be employed by the Packager/Shipper for non-preserved, solid media samples (soil, duff, bark, bulk material), and samples collected on cassettes (air, dust). Section 5.2.2 provides procedures for packaging and shipping aqueous samples (groundwater, surface water), or samples with aqueous content (sediment, sludge). Due to the potential for cross contamination, samples collected on cassettes must not be shipped in the same container as solid media samples. Refer to the guidance document referencing this SOP for temperature control requirements (ice).

1. Verify the samples undergoing shipment meet the definition of an “environmental sample” and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the Health and Safety Manager shall be observed.
2. Select a sturdy shipping container. Ensure that coolers are in good repair. Air and dust samples must be shipped in separate containers from solid media samples.
3. Place samples into the shipping container. During placement, ensure custody seals are securely in place and verify the contents of the shipping cooler against the COC. The COC shall reflect only those samples within the shipping container.
4. Fill all remaining space with bubble wrap or other appropriate space filler, to prevent the sample(s) from being jostled.
5. After the COC has been signed and dated (time included), retain the field copy of the COC. If using a cooler, place the following items into a zip-top plastic bag for inclusion in the cooler: the top two copies of the COC, an analytical parameters table (if applicable), a copy of the investigation-specific analytical requirements summary sheet (applicable to any asbestos analysis), a completed return shipping label for return of the cooler, and any additional contact, results distribution, or billing information. Tape the sealed zip-top bag to the inside of the cooler lid and securely close. If using a box, include all aforementioned documentation inside the box along with the samples.
6. Attach a completed custody seal across the opening of the shipping container on opposite sides. If using a cooler, the cooler lid shall be secured with tape by wrapping each end of the cooler a minimum of two times. The tape shall be affixed to the cooler so that only half of the custody seal is covered, preventing the cooler from being opened without breaking the seal.
7. Secure the completed shipping form to the shipping container. Schedule the container for pickup or drop off at shipper.
8. Once the container is shipped, notify the laboratory of the shipment number and anticipated arrival date/time.

5.2.2 Aqueous or Aqueous-content Samples without Preservatives

This process below will be employed by the Packager/Shipper for non-preserved, aqueous (or aqueous content) samples collected in bottle ware (water, sediment, sludge). Refer to the guidance document referencing this SOP for temperature control requirements (ice).

1. Verify the samples undergoing shipment meet the definition of an “environmental sample” and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the Health and Safety Manager shall be observed.
2. Be sure the caps on all bottles are tightened to prevent leaking. Ensure custody seals are securely in place.
3. For glass containers, wrap each container in bubble wrap and secure with waterproof tape to prevent breakage.
4. Place each plastic or bubble-wrapped glass container into a zip-top bag. Smaller glass containers, such as 40-milliliter vials, may be wrapped together for the same sample.
5. Remove as much trapped air when sealing the bag.

6. Select a sturdy cooler in good repair. To control contents: duct tape closed any interior drain plugs from the inside; duct tape closed any exterior drain plugs from the outside; and line the cooler with two large heavy-duty plastic garbage bags.
7. Place the samples into the cooler with sufficient space to allow for the addition of packing material between the samples. It is preferable to place glass sample bottles and jars into the cooler vertically (glass containers are less likely to break when packed vertically rather than horizontally). During placement, verify the contents of the shipping cooler against the COC. The COC shall reflect only those samples within the cooler.
8. Fill all remaining space with bubble wrap or other appropriate space filler to prevent the sample(s) from being jostled.
9. After the COC has been signed and dated (time included), retain the field copy of the COC. Place the following items into a zip-top plastic bag for inclusion in the cooler: the top two copies of the COC, an analytical parameters table (if applicable), a copy of the Analytical Summary Sheet as provided in the governing document referencing this SOP (only applicable to asbestos analysis), a completed return shipping label for return of the cooler, and any additional contact, results distribution, or billing information. Tape the sealed zip-top bag to the inside of the cooler lid and securely close.
10. Fill all remaining space between the samples with packing material. Remove excess air from garbage bags and seal each bag by securely taping the opening closed and then applying a custody seal on the outermost bag.
11. Attach a completed custody seal across the opening of the cooler on opposite sides. The cooler lid shall be secured with tape by wrapping each end of the cooler a minimum of two times. The tape shall be affixed to the cooler so that only half of the custody seal is covered, preventing the cooler from being opened without breaking the seal.
12. Secure the completed shipping form to the shipping container. Schedule the container for pickup or drop off at shipper.
13. Once the container is shipped, notify the laboratory of the shipment number and anticipated arrival date/time.

5.2.3 Samples Requiring Temperature Controls

If temperature controls (i.e., ice) are required (refer to the guidance document referencing this SOP), in addition to the procedures listed in Section 5.2.1 (for solid media samples) or Section 5.2.2 (for aqueous samples), the Packager/Shipper will:

1. Duct tape closed any drain plugs (inside and outside) and line the cooler with two large heavy-duty plastic garbage bags. (This step will already have been performed for aqueous/aqueous-content samples.)
2. Place ice in one-gallon plastic zip-top bags and properly seal the bags.
3. Place bags of ice on top of and between the samples to ensure adequate temperature controls during transport.
4. Ensure a temperature blank is secured inside the cooler.

5.2.4 All Samples with Preservatives

Prior to shipping samples with preservatives, the Qualified Shipper will determine the amount of preservative in each sample. Excepted quantities of preservatives are provided in the following table:

Excepted Quantities of Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
5 drops = 1 ml		**pH**	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
NaOH	30%	>12	0.08%	--	0.25	0.5	1	2
HCl	2N	<1.96	0.04%	0.2	0.5	1	--	--
HNO_3	6N	<1.62	0.15%	--	2	4	5	8
H_2SO_4	37N	<1.15	0.35%	0.1	0.25	0.5	1	2

Conc. = concentration
ml = milliliters
% = percent
L = liter
NaOH = sodium hydroxide
HCl = hydrochloric acid
HNO_3 = nitric acid
H_2SO_4 = sulfuric acid

In addition to the steps outlined in the appropriate section above for the specific media sampled, these additional steps are to be followed when packaging limited-quantity sample shipments:

1. Nitrile gloves are to be worn by anyone handling the sampling containers.
2. All sample containers will be labeled with the sample number and what preservative is being used. Protect the labels with waterproof tape. At a minimum the sample label must contain:
    - Sample number
    - Project or Case number
    - Date and time of sample collection
    - Preservative
    - Analysis

The FSDS will be used to collect all other sample information.

3. The Packager/Shipper will ensure a trip blank(s) is secured inside the cooler(s).
4. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.

5.3 Post-operation

Shipping documentation will be maintained by the Packager/Shipper to confirm that shipments have been delivered and accepted by the receiver.

6.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

6.1 Training

Every effort will be made to ensure proper sample custody from the point of collection to final disposition. Sample custody will be maintained to the extent possible through proper training, using designated field staff, and providing TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

6.2 Field Checks

Field checks for adherence to this SOP may be performed on a daily basis by the TL (or their designate) for the first week of each investigation. These checks can be extended to once per month as investigation activities continue, and any errors noticed during the checks will be discussed with field personnel and corrected. If investigation activities continue beyond six months, the frequency of assessing sample packaging and shipping procedures will be established by the field Quality Assurance Manager or their designate.

7.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 2-1, Packaging and Shipping Environmental Samples, January 2012.

Libby Asbestos Superfund Site
Site-specific Procedure
Completion of Field Sample Data Sheets

Prepared by: Diane M Roche
CDM Smith
Date: 4/18/12

Reviewed by: Thomas Cook
CDM Smith Technical Reviewer
Date: 4/18/12

Reviewed by: Terry Crowell
CDM Smith Quality Assurance Reviewer
Date: 4/18/12

Revision No.	Date	Reason for Revision
0	5/8/02	--
1	5/16/03	Annual update to align guidance with current versions of FSDSs
2	--	Not finalized/approved
3	4/12/06	Annual update to align guidance with current versions of FSDSs
4	4/13/09	Annual update to align guidance with current versions of FSDSs
5	5/26/09	Minor administrative changes to address FSDS changes
6	4/18/12	Annual update to align guidance with current versions of FSDSs

1.0 Objective

The objective of this site-specific procedure is to establish baseline requirements, procedures, and responsibilities for the completion of field sample data sheets (FSDSs) by the U.S. Environmental Protection Agency (EPA) or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this procedure may be detailed in governing documents referencing this SOP.

2.0 Definitions

Data Entry Tool (DET) – A local MS Access tool used to enter information from the FSDS and used to temporarily store information until it is published to Scribe.

Field sample data sheet (FSDS) – The hard copy form on which sample and location information is recorded.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Response Manager – An EPA data management system used to manage property information.

Scribe – An EPA data management system used manage location, sample, and analytical data.

3.0 Responsibilities

Team Leader (TL) – Responsible for ensuring that FSDSs are completed in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Sampler – Responsible for completing FSDSs in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Field Sample Coordinator (FSC) – Staff member to whom samples and FSDSs are relinquished; responsible for preparing chain-of-custody forms (COCs) and submitting samples to the appropriate project facility.

Office Administrator – Responsible for preparing sample number and location identification (ID) logs and labels, and preparing unique and sequentially numbered FSDSs for completion in the field.

4.0 Operation

4.1 Recording Information for All Sampling Media

This section provides background information, as well as descriptions and instructions for completing FSDS data items common to all sampled media. Data items specific to certain media are discussed in Section 4.2.

Some FSDS data items are required to be completed to be in compliance with EPA data reporting requirements or the governing document referencing this procedure, or to track other critical field information. These data items will be referred to as "required" throughout this procedure. Required data items are indicated on FSDSs with an asterisk (*). A required data item must be populated with an appropriate valid value. Note that "NA" (not applicable) may be a valid value.

Other data items may be required conditionally. These will be referred to as "conditional" throughout this procedure and these fields will not be asterisked on the FSDS. Conditional data items and any corresponding valid values may be specified in EPA data reporting requirements or the governing document referencing this procedure.

Data items that are not required or conditional may be left blank. Information recorded on the FSDS is entered into the DET.

Field team members are not required to line out any labels, initial, or date them, unless they are making a revision. To revise a data item on an FSDS, line through the incorrect data (single line), record the correct data in close proximity to the erroneous data, and date and initial the change.

Sheet No.: A pre-assigned unique, sequential sheet number assigned by an Office Administrator, in the format: $$-###### or $-######, where $ refers to the media being sampled and ###### refers to the sequential number.

Event ID: An identifier for a specific data collection effort, most commonly a combination of the event-specific sample number prefix and the approved date of the document governing the event. These Event IDs use the format: $$-######, where $$ refers to the sample number prefix and ###### refers to the governing document date in MMDDYY format.

Address: The concatenated address (as it appears in Response Manager) of the property being investigated and/or sampled.

Date: The date of sample collection in the form MM/DD/YY. For air samples collected over more than one day using the same cassette, the end date (i.e., date the sample period concludes) will be recorded.

Property ID: For non-OU7 properties, a unique identifier assigned to each property in the format: AD-######, where ###### is a unique number. OU7 Property IDs use the format: AD-2#####. Property IDs should be verified using Response Manager before being transcribed to the FSDS. Property IDs may be used as Location IDs in appropriate circumstances.

Field Logbook No.: The number of the logbook being used to record information specific to the samples on the FSDS.

Page No.: The page number(s) in the logbook being used to record information specific to the samples on the FSDS.

Sampler(s): The first initial and full last name of all members of the field team. For removal-related samples, the Third Party Quality Assurance oversight (TQA) staff member name should also be listed. For data entry, the FSC will select only one of the field team members listed. The company affiliation of the field team member(s) or TQA need only be listed after their name if they work for a company other than "CDM Smith".

Location ID: A unique number assigned to each location representing the investigated and/or sampled area specific to the information on the FSDS. Previously assigned Location IDs should be verified using Scribe before being transcribed to the FSDS, whenever possible. Contact a member of the onsite data management team for assistance with verification.

Location IDs in the format BD-###### will be assigned to (or used for, in the case of previously assigned Building Location IDs) habitable, fully enclosed primary or secondary buildings, including buildings that may have broken windows and/or missing doors. A Building Location ID will be used for samples collected within the habitable, fully enclosed structure, including soil samples from soil floors and samples within understructures (e.g., basement, cellar, crawlspace).

Location IDs in the format XX-###### will be assigned to outdoor investigation areas, including soil areas beneath carports, decks, and porches, or within open structures (e.g., 3-sided structures, carports, and lean-tos). XX-###### Location IDs will not be used during removal soil confirmation sampling.

Location IDs in the format SP-###### will be assigned to outdoor excavated soil areas (including areas with open structures) during removal soil confirmation sampling.

For personal and stationary air samples, a previously assigned Property ID or Building Location ID will be used in most cases. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

For lot blanks, AD-OU4NA is used for the Property ID and Location ID.

For field blanks, generally, the Property ID where field samples are being collected is used for outdoor sampling, while the Building Location ID is used if sampling occurs indoors. For air and dust field blanks specifically, the Location ID should be used that corresponds to the air space where the field blank is exposed (i.e., Property ID for field blanks exposed in outdoor spaces; Building Location ID for field blanks exposed in indoor living spaces).

Sample ID: Unique number assigned to each sample in the format $-##### or $$-#####, where $ or $$ is a one– or two-digit set of characters indicating the governing document referencing this procedure, and ##### is a 5-digit sequential number.

For Field Team Completion, Completed by: Initials of the field team member, verifying that required data items on the FSDS have been completed correctly.

For Field Team Completion, Quality Checked (QC) by: Initials of the second field team member (independent of the member completing the FSDS) or other trained reviewer, verifying that required data items on the FSDS have been completed correctly.

For Data Entry, Entered by: Initials of the FSC or data entry staff performing data entry of FSDS information into the DET.

For Data Entry, QC by: Initials of the FSC or other trained reviewer verifying FSDS data entered into DET is complete and accurate.

4.2 Recording Media-specific Information

The following sections provide instructions for recording media-specific information on FSDSs.

4.2.1 Soil-Like Material

Is this a new Location: Select the appropriate Location ID response. Use "Yes" when assigning a new Location ID; use "No" when a Location ID has previously been assigned, and use "Revised" when revising previously collected location data.

Location Type: Record the location type of the area being investigated and/or sampled. For removal confirmation soil samples, use "EA" for excavation area. For perimeter or clearance air samples, or water samples, use "NA". For General Property Investigation (GPI) locations/samples, select from the following values (abbreviations may be used):

SP – sampling point	EA – excavation area	NA – not applicable
SUA – specific-use area	CUA – common-use area	LUA – limited-use area
RUA – road-use area	NUA – non-use area	PB – primary building
SB – secondary building	SS – secondary structure	

Location Description: Record the description of the area being investigated and/or sampled. Select from the following values (do not abbreviate):

alley	flowerbed	road (paved)
animal pen	former house foundation	road (unpaved)
apartment	garage	root zone
barn	garden	shed
borrow source	greenhouse	shop
building	house	shrub bed
burn pile	lean-to	stockpile
carport	NA	underneath porches/decks
decorative gravel/rock	outhouse	underneath secondary structure
driveway (paved)	park	undeveloped Area
driveway (unpaved)	parking lot (paved)	walkway (paved)
field (maintained)	parking lot (unpaved)	walkway (unpaved)
field (unmaintained)	property	wooded area
fire pit	pumphouse	yard
flower pots	right of way - only	

Location Area: Record the square footage of the area to which the FSDS pertains. This data item may be left blank if not specified in the governing document referencing this procedure.

Location Comment: For GPIs, describe the restoration type applicable to a location. This data item may be left blank if not required by the governing document referencing this procedure.

building	pea gravel	topsoil
chipped rock	potting soil	topsoil w/liner
common fill	sand	washed rock
grass	structural fill	wood chips
landscape rock	tall grass	wooded area

Location Comment 2: Record the detailed description of the location that may not be reflected in the Location Comment. This data item may be left blank if not specified in the governing document referencing this procedure.

Visible Vermiculite: Record the total number of visual inspection points of no (N), low (L), intermediate (M), or high (H) levels of vermiculite observed during the semi-quantitative visual inspection for vermiculite. For visible vermiculite observations corresponding to a sample, the sum of these fields must equal the number of sample aliquots (e.g., 30). If no sample is collected, the sum relates to the estimated location area, as specified in the governing document referencing this procedure. Values for visual inspection point observations (N, L, M, or H) must be provided; use zero to indicate no observations were required/made.

Top Depth: Record the top depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive, whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Bottom Depth: Record the bottom depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive, whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Visible Vermiculite Sub-location: For exterior samples use "Property (exterior)". For GPI interior locations, select from the list below. This data item may be left blank if not specified in the governing document referencing this procedure.

property (exterior)	crawlspace	soil floor
basement	cellar	

Visible Vermiculite Comments: Record any comments pertaining to the visual inspection observation. This data item may be left blank if not specified in the governing document referencing this procedure.

Sample Collected: Circle "Yes" or "No". If no sample is collected, "Z" out and initial the data items from "Sample ID" to "Sample Field Comments".

Sample ID: Record the unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

Sample Time: Record the time (in military units) the sample was collected.

ABS Y/N: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors or outdoors. Use "NA" for field blanks.

Sample PrePostClear: For removal confirmation soil samples, circle the appropriate clearance sequence. For all other samples, circle "NA" unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle "FS" for a field sample, "FD" for a field duplicate, or write in an alternative sample type if specified in the governing document referencing this procedure.

Sample Parent ID: Record the parent Sample ID for soil field QC samples (e.g., duplicates, replicates). Refer to the governing document referencing this procedure for field sample QC requirements.

Composite Y/N: Indicate if the sample collected is a composite. Circle "N" if the sample is a grab sample.

Sample/Inspection Aliquots: For 30-point composite samples, circle "30", or indicate the number of aliquots inspected and/or collected in the space provided. If a grab sample was collected, circle "0".

Sample Location Description: For exterior removal confirmation soil samples, provide the sampling areas designation(s) corresponding to the TQA draft redline sketch. For interior removal confirmation soil samples, record the building description and the sampling areas designation(s) corresponding to the TQA draft redline sketch where the sample was collected (e.g., greenhouse; Area 1; Area 12, pumphouse; Area 3, crawlspace). For GPI and other sampling programs, provide any detailed location information that may not be reflected in the general Location Description, such as restoration type (e.g., structural fill) or specific area of the building that was sampled (e.g., middle of barn, SW corner of crawlspace).

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

4.2.2 Stationary Air

As mentioned in Section 4.1, a previously assigned Property ID or Building Location ID will be used on the FSDS for stationary air samples in most cases. Property IDs are used for stationary air samples collected outside buildings, while Building Location IDs are used for samples collected inside buildings. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

Sample ID: A unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

ABS N/Y: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors, outdoors, both, or NA. The Sample Venue for field blanks should be recorded as "NA". For samples collected inside a vehicle with the windows closed, circle "Indoor". For samples collected inside a vehicle with the windows open, circle "Both".

Sample PrePostClear: For removal clearance air samples, circle the appropriate clearance sequence. For all other samples, including field blanks, circle "NA" unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle "FS" for a field sample, "FD" for a field duplicate, "LB" for lot blank, "DB" for drying blank, or write in an alternative sample type as specified in the governing document referencing this procedure.

Sample Parent ID: Applicable to the high volume sample, when co-located high- and low-volume samples are collected. For the high-volume sample, record the low-volume Sample ID as the Sample Parent ID. For the low-volume sample, the Sample Parent ID is left blank.

Sample Location Description: Provide a detailed description of the indoor or outdoor sample location. Record "Blank" for field blanks. Refer to the governing document referencing this procedure for any additional requirements.

Sample Air Type: Circle the appropriate stationary air type (Ambient or Perimeter). The Sample Air Type for blanks should be recorded as "NA".**Sample Air Volume Type:** When co-located high- and low-volume samples are collected, record "LV" for low-volume or "HV" for high-volume samples. Record "NA" for all other samples.

Flow Meter Type: Circle the applicable flow meter used. Circle "NA" for all types of blank samples.

Cassette Lot Number: Record the cassette lot number of the sample cassettes being used.

Flow Meter ID Number: Record the identification number of the flow meter used. If more than one flow meter is used, use Sample Field Comments to record the additional Flow Meter ID(s).

Pump ID Number: Record the ID of the pump used. If more than one pump is used, use Sample Field Comments to record the additional pump ID(s), and provide the reason for use of multiple pumps. For all types of blank samples, "Z" out the data items from "Pump ID" to "Sample Air Stop Flow".

Sample Air Start Date: Record the start date in the format MM/DD/YY. Note that multiple start and stop dates/times, as well as start and stop flow rates, may need to be recorded for samples collected over multiple days using the same cassette. Refer to the governing document referencing this procedure for additional requirements.

Start Time: Record the starting time (in military units) of each air sample aliquot.

Start Flow: Record the starting pump flow rate, in liters per minute (L/min) for the air sample collected.

Stop Date: Record the stop date in the format MM/DD/YY.

Stop Time: Record the stopping time (in military units) of each air sample aliquot.

Stop Flow: Record the stopping pump flow rate (in L/min) for the air sample collected. If a flow rate is recorded while the pump is running, the stop time and next recorded start time will be the same.

Pump Fault: Circle "Y" or "N" to indicate a pump fault. For all types of blank samples, circle "NA". Use Sample Field Comments to note if a pump faulted during air sample collection, as determined by an unacceptable flow rate deviation (refer to the governing document referencing this procedure for flow rate requirements), or due to a mechanical fault (pump shut-off).

Sample Total Time (min): Sample Total Time is the total sample collection period in minutes (min). TLs will provide direction on calculating sample times. Generally, removal-related air sample total times will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate total times.

Sample Quantity (L): The sample quantity represents the total volume in liters (L) of the sample collected. TLs will provide direction on calculating sample quantities. Generally, removal-related air sample quantities will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate sample quantities.

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

Filter Diameter: For all standard Libby Site air sampling, sample cassettes with a 25-millimeter filter diameter will be used. This data item is pre-printed on the Air FSDS.

Pore Size: For standard Libby Site air sampling, sample cassettes with a 0.8-micron filter pore size will be used. This data item is pre-printed on the Air FSDS.

4.2.3 Personal Air

Complete Personal Air FSDSs as for Stationary Air, with the following adjustments:

Sample PrePostClear: For all samples and blanks circle "NA" unless otherwise specified by the governing document referencing this procedure.

Sample Air Type: Circle one of the following personal air types:

- TWA – Time-weighted average sample, collected over an 8-hour period (may be composited with other personal air samples to represent an average work day)
- EXC – Excursion sample, collected over a 30-minute period (time may be approximate)
- ABS – Sample collected during activity-based sampling (<u>not</u> health and safety related)
- NA – Use for all types of blank samples, or as specified in the governing document referencing this procedure

Personnel ID: Record the 4-digit company-assigned ID of the worker being monitored.

Name: Record the first and last name of the worker being monitored.

Personnel Task: For health and safety-related samples, select from the list below. For samples collected as part of ABS, refer to the governing document referencing this procedure for requirements.

bulk removal	investigation (Level D)	removal oversight (Level D)
demolition	laborer	support personnel
detailing attic	operator	truck driver (Level C)
excavator operator	other	truck driver (Level D)
investigation (Level C)	removal oversight (Level C)	wet wipe/HEPA vac living space

For samples collected at Rainy Creek Rd or Lincoln County Landfill, select the most appropriate value from the list above, and then provide additional information in Sample Field Comments from the list below:

upper dozer	laborer - PAPR
water truck driver – PAPR	equipment operator - PAPR
truck driver – PAPR	truck driver – Level C and Level D

Scribe – An EPA data management system used manage location, sample, and analytical data.

3.0 Responsibilities

Team Leader (TL) – Responsible for ensuring that FSDSs are completed in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Sampler – Responsible for completing FSDSs in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Field Sample Coordinator (FSC) – Staff member to whom samples and FSDSs are relinquished; responsible for preparing chain-of-custody forms (COCs) and submitting samples to the appropriate project facility.

Office Administrator – Responsible for preparing sample number and location identification (ID) logs and labels, and preparing unique and sequentially numbered FSDSs for completion in the field.

4.0 Operation

4.1 Recording Information for All Sampling Media

This section provides background information, as well as descriptions and instructions for completing FSDS data items common to all sampled media. Data items specific to certain media are discussed in Section 4.2.

Some FSDS data items are required to be completed to be in compliance with EPA data reporting requirements or the governing document referencing this procedure, or to track other critical field information. These data items will be referred to as “required” throughout this procedure. Required data items are indicated on FSDSs with an asterisk (*). A required data item must be populated with an appropriate valid value. Note that “NA” (not applicable) may be a valid value.

Other data items may be required conditionally. These will be referred to as “conditional” throughout this procedure and these fields will not be asterisked on the FSDS. Conditional data items and any corresponding valid values may be specified in EPA data reporting requirements or the governing document referencing this procedure.

Data items that are not required or conditional may be left blank. Information recorded on the FSDS is entered into the DET.

Field team members are not required to line out any labels, initial, or date them, unless they are making a revision. To revise a data item on an FSDS, line through the incorrect data (single line), record the correct data in close proximity to the erroneous data, and date and initial the change.

Sheet No.: A pre-assigned unique, sequential sheet number assigned by an Office Administrator, in the format: $$-###### or $-######, where $ refers to the media being sampled and ###### refers to the sequential number.

Event ID: An identifier for a specific data collection effort, most commonly a combination of the event-specific sample number prefix and the approved date of the document governing the event. These Event IDs use the format: $$-######, where $$ refers to the sample number prefix and ###### refers to the governing document date in MMDDYY format.

Address: The concatenated address (as it appears in Response Manager) of the property being investigated and/or sampled.

Date: The date of sample collection in the form MM/DD/YY. For air samples collected over more than one day using the same cassette, the end date (i.e., date the sample period concludes) will be recorded.

Property ID: For non-OU7 properties, a unique identifier assigned to each property in the format: AD-######, where ###### is a unique number. OU7 Property IDs use the format: AD-2#####. Property IDs should be verified using Response Manager before being transcribed to the FSDS. Property IDs may be used as Location IDs in appropriate circumstances.

Field Logbook No.: The number of the logbook being used to record information specific to the samples on the FSDS.

Page No.: The page number(s) in the logbook being used to record information specific to the samples on the FSDS.

Sampler(s): The first initial and full last name of all members of the field team. For removal-related samples, the Third Party Quality Assurance oversight (TQA) staff member name should also be listed. For data entry, the FSC will select only one of the field team members listed. The company affiliation of the field team member(s) or TQA need only be listed after their name if they work for a company other than "CDM Smith".

Location ID: A unique number assigned to each location representing the investigated and/or sampled area specific to the information on the FSDS. Previously assigned Location IDs should be verified using Scribe before being transcribed to the FSDS, whenever possible. Contact a member of the onsite data management team for assistance with verification.

Location IDs in the format BD-###### will be assigned to (or used for, in the case of previously assigned Building Location IDs) habitable, fully enclosed primary or secondary buildings, including buildings that may have broken windows and/or missing doors. A Building Location ID will be used for samples collected within the habitable, fully enclosed structure, including soil samples from soil floors and samples within understructures (e.g., basement, cellar, crawlspace).

Location IDs in the format XX-###### will be assigned to outdoor investigation areas, including soil areas beneath carports, decks, and porches, or within open structures (e.g., 3-sided structures, carports, and lean-tos). XX-###### Location IDs will not be used during removal soil confirmation sampling.

Location IDs in the format SP-###### will be assigned to outdoor excavated soil areas (including areas with open structures) during removal soil confirmation sampling.

For personal and stationary air samples, a previously assigned Property ID or Building Location ID will be used in most cases. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

For lot blanks, AD-OU4NA is used for the Property ID and Location ID.

For field blanks, generally, the Property ID where field samples are being collected is used for outdoor sampling, while the Building Location ID is used if sampling occurs indoors. For air and dust field blanks specifically, the Location ID should be used that corresponds to the air space where the field blank is exposed (i.e., Property ID for field blanks exposed in outdoor spaces; Building Location ID for field blanks exposed in indoor living spaces).

Sample ID: Unique number assigned to each sample in the format $-##### or $$-#####, where $ or $$ is a one– or two-digit set of characters indicating the governing document referencing this procedure, and ##### is a 5-digit sequential number.

For Field Team Completion, Completed by: Initials of the field team member, verifying that required data items on the FSDS have been completed correctly.

For Field Team Completion, Quality Checked (QC) by: Initials of the second field team member (independent of the member completing the FSDS) or other trained reviewer, verifying that required data items on the FSDS have been completed correctly.

For Data Entry, Entered by: Initials of the FSC or data entry staff performing data entry of FSDS information into the DET.

For Data Entry, QC by: Initials of the FSC or other trained reviewer verifying FSDS data entered into DET is complete and accurate.

4.2 Recording Media-specific Information

The following sections provide instructions for recording media-specific information on FSDSs.

4.2.1 Soil-Like Material

Is this a new Location: Select the appropriate Location ID response. Use “Yes” when assigning a new Location ID; use “No” when a Location ID has previously been assigned, and use “Revised” when revising previously collected location data.

Location Type: Record the location type of the area being investigated and/or sampled. For removal confirmation soil samples, use “EA” for excavation area. For perimeter or clearance air samples, or water samples, use “NA”. For General Property Investigation (GPI) locations/samples, select from the following values (abbreviations may be used):

SP – sampling point	EA – excavation area	NA – not applicable
SUA – specific-use area	CUA – common-use area	LUA – limited-use area
RUA – road-use area	NUA – non-use area	PB – primary building
SB – secondary building	SS – secondary structure	

Location Description: Record the description of the area being investigated and/or sampled. Select from the following values (do not abbreviate):

alley	flowerbed	road (paved)
animal pen	former house foundation	road (unpaved)
apartment	garage	root zone
barn	garden	shed
borrow source	greenhouse	shop
building	house	shrub bed
burn pile	lean-to	stockpile
carport	NA	underneath porches/decks
decorative gravel/rock	outhouse	underneath secondary structure
driveway (paved)	park	undeveloped Area
driveway (unpaved)	parking lot (paved)	walkway (paved)
field (maintained)	parking lot (unpaved)	walkway (unpaved)
field (unmaintained)	property	wooded area
fire pit	pumphouse	yard
flower pots	right of way - only	

Location Area: Record the square footage of the area to which the FSDS pertains. This data item may be left blank if not specified in the governing document referencing this procedure.

Location Comment: For GPIs, describe the restoration type applicable to a location. This data item may be left blank if not required by the governing document referencing this procedure.

building	pea gravel	topsoil
chipped rock	potting soil	topsoil w/liner
common fill	sand	washed rock
grass	structural fill	wood chips
landscape rock	tall grass	wooded area

Location Comment 2: Record the detailed description of the location that may not be reflected in the Location Comment. This data item may be left blank if not specified in the governing document referencing this procedure.

Visible Vermiculite: Record the total number of visual inspection points of no (N), low (L), intermediate (M), or high (H) levels of vermiculite observed during the semi-quantitative visual inspection for vermiculite. For visible vermiculite observations corresponding to a sample, the sum of these fields must equal the number of sample aliquots (e.g., 30). If no sample is collected, the sum relates to the estimated location area, as specified in the governing document referencing this procedure. Values for visual inspection point observations (N, L, M, or H) must be provided; use zero to indicate no observations were required/made.

Top Depth: Record the top depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive, whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Bottom Depth: Record the bottom depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive, whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Visible Vermiculite Sub-location: For exterior samples use “Property (exterior)”. For GPI interior locations, select from the list below. This data item may be left blank if not specified in the governing document referencing this procedure.

property (exterior)	crawlspace	soil floor
basement	cellar	

Visible Vermiculite Comments: Record any comments pertaining to the visual inspection observation. This data item may be left blank if not specified in the governing document referencing this procedure.

Sample Collected: Circle “Yes” or “No”. If no sample is collected, “Z” out and initial the data items from “Sample ID” to “Sample Field Comments”.

Sample ID: Record the unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

Sample Time: Record the time (in military units) the sample was collected.

ABS Y/N: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors or outdoors. Use “NA” for field blanks.

Sample PrePostClear: For removal confirmation soil samples, circle the appropriate clearance sequence. For all other samples, circle “NA” unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle “FS” for a field sample, “FD” for a field duplicate, or write in an alternative sample type if specified in the governing document referencing this procedure.

Sample Parent ID: Record the parent Sample ID for soil field QC samples (e.g., duplicates, replicates). Refer to the governing document referencing this procedure for field sample QC requirements.

Composite Y/N: Indicate if the sample collected is a composite. Circle “N” if the sample is a grab sample.

Sample/Inspection Aliquots: For 30-point composite samples, circle “30”, or indicate the number of aliquots inspected and/or collected in the space provided. If a grab sample was collected, circle “0”.

Sample Location Description: For exterior removal confirmation soil samples, provide the sampling areas designation(s) corresponding to the TQA draft redline sketch. For interior removal confirmation soil samples, record the building description and the sampling areas designation(s) corresponding to the TQA draft redline sketch where the sample was collected (e.g., greenhouse; Area 1; Area 12, pumphouse; Area 3, crawlspace). For GPI and other sampling programs, provide any detailed location information that may not be reflected in the general Location Description, such as restoration type (e.g., structural fill) or specific area of the building that was sampled (e.g., middle of barn, SW corner of crawlspace).

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

4.2.2 Stationary Air

As mentioned in Section 4.1, a previously assigned Property ID or Building Location ID will be used on the FSDS for stationary air samples in most cases. Property IDs are used for stationary air samples collected outside buildings, while Building Location IDs are used for samples collected inside buildings. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

Sample ID: A unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

ABS N/Y: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors, outdoors, both, or NA. The Sample Venue for field blanks should be recorded as “NA”. For samples collected inside a vehicle with the windows closed, circle “Indoor”. For samples collected inside a vehicle with the windows open, circle “Both”.

Sample PrePostClear: For removal clearance air samples, circle the appropriate clearance sequence. For all other samples, including field blanks, circle “NA” unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle “FS” for a field sample, “FD” for a field duplicate, “LB” for lot blank, “DB” for drying blank, or write in an alternative sample type as specified in the governing document referencing this procedure.

Sample Parent ID: Applicable to the high volume sample, when co-located high- and low-volume samples are collected. For the high-volume sample, record the low-volume Sample ID as the Sample Parent ID. For the low-volume sample, the Sample Parent ID is left blank.

Sample Location Description: Provide a detailed description of the indoor or outdoor sample location. Record "Blank" for field blanks. Refer to the governing document referencing this procedure for any additional requirements.

Sample Air Type: Circle the appropriate stationary air type (Ambient or Perimeter). The Sample Air Type for blanks should be recorded as "NA".**Sample Air Volume Type:** When co-located high- and low-volume samples are collected, record "LV" for low-volume or "HV" for high-volume samples. Record "NA" for all other samples.

Flow Meter Type: Circle the applicable flow meter used. Circle "NA" for all types of blank samples.

Cassette Lot Number: Record the cassette lot number of the sample cassettes being used.

Flow Meter ID Number: Record the identification number of the flow meter used. If more than one flow meter is used, use Sample Field Comments to record the additional Flow Meter ID(s).

Pump ID Number: Record the ID of the pump used. If more than one pump is used, use Sample Field Comments to record the additional pump ID(s), and provide the reason for use of multiple pumps. For all types of blank samples, "Z" out the data items from "Pump ID" to "Sample Air Stop Flow".

Sample Air Start Date: Record the start date in the format MM/DD/YY. Note that multiple start and stop dates/times, as well as start and stop flow rates, may need to be recorded for samples collected over multiple days using the same cassette. Refer to the governing document referencing this procedure for additional requirements.

Start Time: Record the starting time (in military units) of each air sample aliquot.

Start Flow: Record the starting pump flow rate, in liters per minute (L/min) for the air sample collected.

Stop Date: Record the stop date in the format MM/DD/YY.

Stop Time: Record the stopping time (in military units) of each air sample aliquot.

Stop Flow: Record the stopping pump flow rate (in L/min) for the air sample collected. If a flow rate is recorded while the pump is running, the stop time and next recorded start time will be the same.

Pump Fault: Circle "Y" or "N" to indicate a pump fault. For all types of blank samples, circle "NA". Use Sample Field Comments to note if a pump faulted during air sample collection, as determined by an unacceptable flow rate deviation (refer to the governing document referencing this procedure for flow rate requirements), or due to a mechanical fault (pump shut-off).

Sample Total Time (min): Sample Total Time is the total sample collection period in minutes (min). TLs will provide direction on calculating sample times. Generally, removal-related air sample total times will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate total times.

Sample Quantity (L): The sample quantity represents the total volume in liters (L) of the sample collected. TLs will provide direction on calculating sample quantities. Generally, removal-related air sample quantities will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate sample quantities.

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

Filter Diameter: For all standard Libby Site air sampling, sample cassettes with a 25-millimeter filter diameter will be used. This data item is pre-printed on the Air FSDS.

Pore Size: For standard Libby Site air sampling, sample cassettes with a 0.8-micron filter pore size will be used. This data item is pre-printed on the Air FSDS.

4.2.3 Personal Air

Complete Personal Air FSDSs as for Stationary Air, with the following adjustments:

Sample PrePostClear: For all samples and blanks circle "NA" unless otherwise specified by the governing document referencing this procedure.

Sample Air Type: Circle one of the following personal air types:

- TWA – Time-weighted average sample, collected over an 8-hour period (may be composited with other personal air samples to represent an average work day)
- EXC – Excursion sample, collected over a 30-minute period (time may be approximate)
- ABS – Sample collected during activity-based sampling (<u>not</u> health and safety related)
- NA – Use for all types of blank samples, or as specified in the governing document referencing this procedure

Personnel ID: Record the 4-digit company-assigned ID of the worker being monitored.

Name: Record the first and last name of the worker being monitored.

Personnel Task: For health and safety-related samples, select from the list below. For samples collected as part of ABS, refer to the governing document referencing this procedure for requirements.

bulk removal	investigation (Level D)	removal oversight (Level D)
demolition	laborer	support personnel
detailing attic	operator	truck driver (Level C)
excavator operator	other	truck driver (Level D)
investigation (Level C)	removal oversight (Level C)	wet wipe/HEPA vac living space

For samples collected at Rainy Creek Rd or Lincoln County Landfill, select the most appropriate value from the list above, and then provide additional information in Sample Field Comments from the list below:

upper dozer	laborer - PAPR
water truck driver – PAPR	equipment operator - PAPR
truck driver – PAPR	truck driver – Level C and Level D

Libby Asbestos Superfund Site
Site-specific Procedure
30-point Composite Sampling of Surface Soil for Asbestos

Prepared by: ____________ Date: 2/18/13
CDM Smith

Reviewed by: ____________ Date: 2/18/13
CDM Smith Technical Reviewer

Reviewed by: Robert R. Alexander Date: 2/18/13
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	5/7/02	--
1	5/17/03	• Administrative updates • Updated land use area designations • Updated sampling approach to collect samples in large land use areas (driveways and yards) where vermiculite is observed
2	5/10/07	• Administrative updates • Addition of Responsibilities and Sample Custody sections • Separate QA/QC requirements into new section • Updated sampling approach and collection requirements, including: – subsample requirements changed from 5-point to 30-point – refinement of property zone definitions and sizes – updated land use area designations – changes in sample depth increments for use areas – use of formalized procedure for the semi-quantitative estimation of visible vermiculite in soil
3	5/1/12	• Administrative updates • Eliminate the use of bowls used to homogenize soil samples • Eliminate the use of aluminum foil for wrapping re-usable sampling equipment during transport • Addition of reference to Libby Site-specific standard Operating Procedures throughout • Change in composited soil sample size from 2,000 – 2,500 grams to 750 – 1,000 grams
4	2/12/13	• Clarify the definition of visible vermiculite

1.0 Objective

The objective of this site-specific procedure is to establish baseline requirements, procedures, and responsibilities for the collection of 30-point composite surface soil samples by the U.S.

Environmental Protection Agency (EPA) or its contractors related to investigations conducted at the Libby Asbestos Superfund Site (Libby Site). This procedure describes the equipment and operations to be used for sampling surface soils for the analysis of Libby amphibole asbestos. Additions or modifications to this procedure may be detailed in governing documents referencing this procedure.

2.0 Definitions

Composite sampling – A sampling approach in which multiple sample points are compiled together and submitted for analysis as a single sample.

Field sample data sheet (FSDS) – The controlled (i.e., pre-numbered and tracked) hard copy form on which sample and location information, and any visible vermiculite observations, is recorded.

Land use area – A portion of a property segregated according to how the property owner uses the area.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the current version of the OU boundary map.

Point inspection (PI) – A PI is an intrusive visual inspection of the top portions of the soil at a randomly selected point within a land use zone. A PI consists of the active displacement of the surface soil with a small shovel and visual inspection of the displaced soil and surface soil within an approximate 2-foot radius of the displaced soil (i.e., immediate field of view) for visible vermiculite. If VV is observed during the PI, the location and a semi-quantitative estimate of VV will be recorded.

Subsample – The portion of a composite sample representing a discreet location within the sampled area.

Visible Vermiculite – Exfoliated and/or unexfoliated vermiculite, amphibole asbestiform minerals, and mine tailings present in soils as part of response actions – herein collectively referred to as visible vermiculite (VV).

3.0 Responsibilities

Successful execution of this procedure requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for collecting soil samples using this procedure will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this procedure.

Team Leader (TL) – The TL is responsible for overseeing the sample collection process outlined in this procedure, and for checking and verifying that the work performed satisfies the objectives of the governing document referencing this procedure. The TL will communicate with the field team members regarding specific collection objectives, and will communicate the need for any deviations from this procedure with the appropriate client personnel, and document the deviations using a Libby Field Record of Modification Form, as provided in the governing document referencing this procedure.

Field Team Members - Field team members performing the sampling described in this procedure are responsible for adhering to the tasks specified herein. The field team members should have limited discretion with regard to collection procedures but should exercise judgment regarding the exact location of sample points, within the boundaries outlined by the TL.

4.0 Equipment

The following equipment will be used during implementation of this procedure:

- Measuring tape or wheel – Used to estimate the square footage of each land use area.
- Pin flags – Used to identify subsample points within each sampling area.
- Trowel or push probe
- Shovel
- Gallon-sized plastic zip-top bags – Used to homogenize soil subsamples following collection (two bags per sample).
- Personal protective equipment (PPE) – For personal protection and to prevent cross-contamination of samples (e.g., disposable, powderless plastic or latex gloves).
- Field sprayers – Used to suppress dust during sample collection and to decontaminate non-disposable sampling equipment between samples.
- De-mineralized water – Used in field sprayers to suppress dust and to clean and decontaminate sampling equipment.
- Plastic bristle brush – Used to clean and decontaminate sampling equipment.
- Alconox – Used to clean and decontaminate sampling equipment weekly.
- Paper towels – Used to dry decontaminated sampling equipment.
- 6-mil poly bag – Used to store and dispose of investigation-derived waste (IDW).
- Trash bag – Used to store and dispose of general trash.
- Indelible ink pen (blue or black ink only)
- Field logbook – Used to record progress of sampling effort and record any problems and field observations.
- Blank FSDSs
- Sample Identification (ID) Labels – Pre-printed self-adhesive stickers used to label sample containers and on field documentation (e.g., FSDSs).
- Cooler or other rigid container – Used to store samples while in the field.
- Custody Seals – Self-adhesive seals applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

5.0 Sampling Approach

Upon arrival at each property, the field team will locate all parcels requiring sample collection depending on the investigation-specific objectives detailed in governing guidance documents. Parcels on a property will be sectioned into zones that share a similar land use. Zones established by land use areas may be subdivided based on site conditions (e.g., access, construction setup considerations, etc.). Use areas include:

- Specific-use area (SUA): flowerbed, garden, stockpile, play area, dog pen, driveway (non-paved), parking lot (non-paved), road (non-paved), alley (non-paved), fire pit/burn pile
- Common-use area (CUA): yard, former garden, former flowerbed, walkway
- Limited-use area (LUA): pasture, maintained/mowed field, overgrown areas with trails/footpaths, overgrown areas in between SUAs/CUAs
- Non-use area (NUA): wooded lot, un-maintained field. NUAs will be identified but will not be sampled because they are not presently considered a complete exposure pathway. However, to the extent that NUAs may become a complete exposure pathway in the future, they may be revisited.
- Primary building (PB) – crawlspace, earthen basement
- Secondary building (SB): soil floor of garage, pumphouse, shed, greenhouse, etc.

After areas have been designated as zones (i.e., SUA zones, CUA zones, LUA zones, etc.), the field team will measure the zones with a measuring wheel and label the zone type and approximate square footage on the field sketch and/or design drawings. This procedure does not specify a minimum or maximum square footage restriction on any zone; however, the governing document referencing this procedure may specify zone size.

In establishing zones at the property, no area type may be combined with any other area type. For example, driveways and flowerbeds are both SUAs but will be separated into unique zones for soil sampling. Similarly, large CUAs such as yards may be subdivided into front yard, side yard, and back yard zones dependent on site conditions. Sectioning properties into additional zones will be at the discretion of the TL but consistent among the teams. Conversely, not all land use areas previously mentioned will be applicable at every property.

It is anticipated that SUA, PB, and SB zones will generally tend to be smaller areas. Combining small, proximal SUAs of similar type into one zone will be at the discretion of the TL but consistent among teams (e.g., two separate flowerbeds). With the exception of proximal SUAs, all other land use areas will be contiguous when establishing zones at each property.

Composite sampling requires soil collection from multiple (subsample) points. Composite samples will be collected from similar land use areas (i.e., SUA, CUA, etc.) and will not be combined with any other use area. One composite sample will be collected from each zone that does not contain visual vermiculite.

For SUAs (e.g., driveway, garden, dog pen, etc.), composite samples will be collected from the 0- to 6-inch depth interval. If a depth of 6 inches cannot be attained given the varying levels of compaction in driveways, roads, etc. the maximum depth attainable will be documented on the FSDS. For non-SUAs (e.g., yard, former flowerbed, crawlspace, etc.), composite samples will be collected from the 0- to 3-inch depth interval. All composite soil samples will have 30 subsamples (i.e., 30-point composite sample) of approximately equal size for a final sample volume between 750 and 1,000 grams. Table 1 lists the sample depth for each type of land use area.

Table 1. Sampling Area and Depth

Land Use Area	Sampling Depth Increment (inches)
Specific-use Area (SUA)	0 – 6
Common-use Areas (CUA)	0 – 3
Limited-use Area (LUA)	0 – 3
Non-use Area (NSA)	Not Sampled
Interior Surface Area (ISA)	0 – 3

As each subsample is collected, the soil will be inspected for VV and the location and semi-quantitative estimates of VV will be recorded on the FSDS in accordance with the current version of CDM-LIBBY-06 (Semi-Quantitative Visual Estimation of Vermiculite in Soil). It should be noted that VV estimates will not be recorded using a Visual Vermiculite Estimation Form.

Areas of SUAs with VV will not be sampled. Instead, the location will be recorded in the field logbook and on the field sketch or design drawing. If the SUA is of substantial size (greater than 1,000 square feet [ft^2]), and the VV is localized, additional PIs will be collected to determine the extent of VV and a sample will be collected from the remainder of the zone that does not contain VV. If the SUA measures less than 1,000 ft^2 and VV is present, a sample will not be collected from that SUA. Proximal SUAs will not be combined into a SUA zone if VV is present. If VV is not observed, proceed with sample collection of the SUA zone.

6.0 Sample Collection

Don the appropriate PPE as specified in the governing health and safety plan and/or governing document referencing this procedure. A new pair of disposable gloves is to be worn for each sample collected. Segregate land use areas on the property into zones as described in Section 5.0. To reduce dust generation during sampling, use a sprayer with de-mineralized water to wet each subsample location prior to collection. Use the trowel to check beneath the surface soil layer, but do not advance more than 6 inches. If VV is observed, record the information on the field sketch or design drawing.

Within each zone, select 30 subsample locations equidistant from each other. These 30 subsample locations will comprise the 30-point composite sample for that zone. All composite subsamples will originate from the same land use area – do not mix subsamples from one land use area with subsamples from a different land use area.

Clean the subsample locations of twigs, leaves, and other vegetative material that can be easily removed by hand. Using the trowel or push probe, excavate a hole in the soil approximately 2 inches in diameter and 6 inches deep for SUAs, or 3 inches deep for non-SUAs, while placing the excavated material directly inside the gallon-sized zip-top plastic bag. Repeat this step for each subsequent subsample until the appropriate number of composite subsamples has been collected.

As each subsample is collected, inspect the location for VV as prescribed in the current version of CDM-LIBBY-06 (Semi-Quantitative Visual Estimation of Vermiculite in Soil).

Homogenize the sample as required by the governing document referencing this procedure. Once the sample is homogenized, fill the zip-top plastic bag approximately a quarter full (750 – 1,000 grams of material). Affix the sample ID label to the inside of the bag and write the sample ID number on the outside of the bag, or affix an additional label using clear packing tape. The sample ID number format will be specified in the governing document referencing this procedure. Double bag the sample and repeat the labeling process for the outer bag.

Decontaminate equipment between composite samples (not between subsamples of one sample), as discussed in Section 7.2 below.

Repeat steps outlined above until all samples from a property have been collected. Refer to Section 8.2 for field quality control (QC) sample requirements.

7.0 Associated Procedures

7.1 Field Documentation

Field documentation for samples collected using this procedure will follow the current versions of CDM-LIBBY-03 (Completion of Field Sample Data Sheets), and EPA-LIBBY-2012-01 (Field Logbook Content and Control) unless otherwise specified in the governing document referencing this procedure.

7.2 Field Equipment Decontamination

All reusable sampling equipment must be decontaminated between composite samples in accordance with EPA-LIBBY-2012-04 (Field Equipment Decontamination), or as otherwise specified in the governing document referencing this procedure.

7.3 IDW

IDW will be managed as described in EPA-LIBBY-2012-05 (Handling IDW) and any other applicable governing documents. In general, replace the soil plug with excess sample volume. The soil should be placed back into the hole and tamped down lightly. If sandy areas such as playgrounds are sampled, refilling the soil plug is not necessary. Rinse water, the roots of vegetation removed during sampling, and any excess soil volume may be returned to the sampled area.

Spent wipes, gloves, and PPE must be disposed of or stored properly as IDW in accordance with EPA-LIBBY-2012-05 (Handling IDW), or as otherwise specified in the governing document referencing this procedure.

7.4 Sample Custody, Packaging, and Shipping

Sample custody requirements for samples collected using this procedure will follow the current version of EPA-LIBBY-2012-06 (Sample Custody), unless otherwise specified in the governing document referencing this procedure.

As may be applicable, sample packaging and shipping will follow the procedures outlined in EPA-LIBBY-2012-07, unless otherwise specified in the governing document referencing this procedure.

8.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this procedure will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this procedure.

8.1 Training

Every effort will be made to ensure consistency in collecting surface soil samples in support of the Libby Site. Consistency will be achieved to the extent possible through proper training, using designated field staff, and providing TL oversight. Any deficiencies or inconsistencies in implementing this procedure noted by the TL will require re-training of field team members.

8.2 Field Quality Control Samples

Soil field duplicate samples will be collected at the rate specified in the governing document referencing this procedure. Field duplicate samples will be collected as co-located samples in the same zone as the parent sample. The duplicate will be collected from the same number of subsamples as the parent sample, but the subsample locations of the duplicate sample will be randomly located in the zone. The inspection for VV at each subsample location will follow the same protocol as referenced above. These samples will be independently collected with separate sampling equipment or with the original sampling equipment after it has been properly decontaminated. For tracking purposes, the parent/duplicate sample relationship will be recorded in accordance with sample documentation requirements stated in the governing document referencing this procedure. These samples will be used to determine the variability of sample results in a given land use area, but will not be used to determine variability in sampling technique.

Libby Asbestos Superfund Site
Site-specific Procedure
Semi-Quantitative Visual Estimation of Vermiculite in Soils

Prepared by: ______________ Date: 3/20/13
CDM Smith

Reviewed by: ______________ Date: 3/20/13
CDM Smith Technical Reviewer

Reviewed by: ______________ Date: 3/20/13
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	10/12/06	--
1	5/10/07	• To refine the process after initial trial phase.
2	03/20/13	• To reflect current documentation procedures and clarify the definition of visible vermiculite. • To align with current procedure format.

1.0 Objective

The EPA will identify and delineate the extent of any visible vermiculite, amphibole asbestiform minerals, and mine tailings suspected to be sourced from the former W.R. Grace mine – herein collectively referred to as visible vermiculite (VV) – present in soils as part of investigations conducted at the Libby Asbestos Superfund Site (Site) and specified in governing documents referencing this procedure. The goal of this standardized procedure is to provide a consistent approach to identify and characterize any VV present in soils.

The semi-quantitative approach presented in this procedure for visually estimating VV in soil will be revised as required to optimize data collection as the sampling teams gain experience. This will be accomplished by expanding and/or improving this procedure, supporting pictorial standards, and additional electronic data acquisition efforts, as necessary.

2.0 Definitions

Specific-use Area (SUA) – Discrete exterior parcels on a property with a designated specific use. Due to the nature of activities typically carried out in SUAs, residents may be especially vulnerable to exposures when Libby amphibole asbestos (LA)-contaminated soil becomes airborne. SUAs may be bare or covered with varying amounts of vegetation. SUAs include, but are not limited to:

- Flowerbeds
- Gardens
- Stockpiles

- Play Areas
- Dog Pens
- Driveways (non-paved)[1]
- Parking Lots (non-paved)
- Roads (non-paved)
- Alleys (non-paved)

Common-use Area (CUA) – Exterior parcels on a property with varied or generic use. CUAs may be bare or covered with varying amounts of vegetation. CUAs include, but are not limited to:

- Walkways
- Yards (front, back, side, etc.)
- Former Gardens
- Former Flowerbeds

Limited-use Area (LUA) – Exterior parcels on a property that are accessed, utilized, and maintained on a very limited basis. LUAs may be bare or covered with varying amounts of vegetation. LUAs include, but are not limited to:

- Pastures
- Maintained/Mowed Fields
- Area underneath porches/decks[2]
- Overgrown Areas (with trails/footpaths, or between SUAs/CUAs)

Primary Building (PB) – Has four walls and a roof, a fully-enclosed design, and is intended for residential or commercial occupancy. PBs include, but are not limited to:

- Houses (including understructures)
- Some shops (when the shop is the primary occupied building on the property)
- Warehouses

Secondary Building (SB) – Has four walls and a roof, a fully-enclosed design, and is large enough for human entry. SBs include, but are not limited to:

- Garages
- Some shops (when another primary building is present on the property)
- Barns
- Sheds

[1] Non-paved driveways considered an SUA starting 2007 – previously considered a CUA.
[2] The soils underneath porches and decks will be classified as CUAs or LUAs depending on ground clearance and accessibility to homeowners and pets. If these areas are not accessible, they will be classified as NUAs.

- Enclosed lean-tos
- Some pump houses
- Larger animal houses

Secondary Structure (SS) – Designed to be open on at least one side and/or is mobile. Some SSs may be enclosed similar to a SB, but are too small or are not intended for human occupancy (e.g., pump or dog houses). SSs include, but are not limited to:

- Carports
- Open lean-tos
- Some pump houses
- Dog houses
- Other small animal housing

Non-use Area (NUA) – Exterior parcels on a property with no current use (e.g., areas that are un-maintained and not accessed). NUAs may be bare or covered with varying amounts of vegetation. NUAs include:

- Wooded lots
- Un-maintained fields
- Inaccessible areas below porches/decks

Because NUAs are not currently accessed, they are not presently considered a complete exposure pathway. As such, semi-quantitative visual estimates of vermiculite in soil will not be captured at this time. However, to the extent that NUAs may become a complete exposure pathway in the future at a property, the EPA may revisit NUAs at a later date or include NUAs as part of long-term site operations and maintenance.

Zone[3] – Parcels on a property that share a similar land use or subdivisions of a land use area based on site conditions (e.g., access, construction setup considerations) or sampling requirements. Within a zone, no area type may be combined with any other area type. For example, driveways and flowerbeds are both SUAs but will be separated into unique zones for visual inspection. Similarly, large CUAs such as yards may be subdivided into front yard, side yard, and back yard zones depending on site conditions. Sectioning properties into additional zones will be at the discretion of the field team leader (FTL) but consistent among the teams using this procedure as specified in the governing document referencing this procedure.

It is anticipated that SUA, PB, SB, and SS zones will generally tend to be smaller parcels. Combining small, proximal SUAs into one zone will be at the discretion of the FTL but consistent among the teams. In addition, combining small, proximal CUAs into one zone will be at the discretion of the

[3] The restriction on the maximum square footage of SUA zones (1,000 ft^2) and non-SUA zones (2, 500 ft^2) was eliminated from a previous iteration of this SOP after the data were reviewed by the EPA and determined to sufficiently characterize the presence of VV regardless of zone square footage. Additionally, this will allow the flexibility necessary for field teams to identify areas of zones most cost effectively for removal purposes.

FTL but consistent among teams. No PB, SB, or SS will be combined with any other PB, SB, or SS for visual inspection. There is not a maximum square footage restriction for any zone.

Point Inspection (PI) – Used in SUA, CUA, LUA, PB, SB, and SS zones. A PI is an intrusive visual inspection of the top portions of the soil at a randomly selected point within a zone. A PI consists of the active displacement of the surface soil with a small shovel and visual inspection of the displaced soil to determine if VV is present. If VV is observed during the PI, the location and a semi-quantitative estimate of VV contamination will be recorded.

Libby Asbestos Superfund Site (site) - All buildings and land within the boundaries of each operable unit (OU) of the site as illustrated on the most recent version of the OU boundary map.

3.0 Responsibilities

Field Team Leader – The FTL is responsible for overseeing the visual inspection process for their field teams, ensuring field team members are adequately trained in this procedure, and checking for consistency among their field teams.

Field team members – Field team members are responsible for conducting visual inspection, as specified in this procedure and the governing document referencing this procedure, and reporting any irregular observations or issues to the FTL.

4.0 Applicability

This procedure applies to properties within the site that will undergo screening and detailed investigations and, as applicable, certain risk-based investigations. Investigation-specific modifications to this procedure shall be outlined in the investigation-specific guidance document. The following locations on a property will be evaluated for the presence/absence of VV:

- All zones where soil samples are being collected.
- All zones requiring visual inspection per the requirements in the governing document referencing this procedure.

5.0 Procedure

Figure 1 illustrates the procedures and decision rules for this procedure. The three primary procedural steps are listed below:

- Establish preliminary zones
- Perform PI
- Perform semi-quantification of VV

Each is described in the following subsections.

5.1 Establish Preliminary Zones

Upon arrival at the property, the field team will locate all areas requiring visual inspection. Parcels will be identified as SUA zones, CUA zones, LUA zones, PB zones, SB zones, SS zones, or NUA zones.

Zones will be assigned according to the definitions provided above. Zone boundaries may be updated on the field sketch based on visual inspection results.

5.2 Point Inspections[4]

As defined above, a PI is an intrusive visual inspection performed at randomly selected points across the entire surface of a zone. Professional judgment may be used to determine the exact location of PIs; however, the following guidelines will be implemented to maintain consistency.

A minimum of 30 PIs will be evaluated per zone if sampling is required within that zone. If soil sampling is not required, a minimum of five PIs will be evaluated within each zone. Zones larger than 500 square feet (ft^2) will require evaluation at a minimum of 1 PI per 100 ft^2 (10 foot by 10 foot area). The PI locations will be randomly selected and will be spatially representative of the entire zone. Locations of the PIs and semi-quantitative estimates of VV (i.e., low [L], intermediate [M] or high [H]) will be recorded on the field sketch for each PI. While a minimum of five PIs will be conducted per zone, there is no set maximum. Rather, the maximum number of PIs is variable, dependent upon the total area of the zone and achieving the minimum required frequency of one PI per 100 ft^2.

The following sections outline procedures for inspecting each use area (e.g., SUA, CUA, LUA, PB, SB, SS). The procedure for semi-quantification of VV is provided in the next section.

<u>SUA Zone:</u>

- Use a spade or trowel to remove any cover material, including excess debris (e.g., mulch, rock) and organic material, from the surface of the soil. Remove and visually inspect soil to a depth of 0-6 inches below ground surface[5].
- If a depth of 6 inches cannot be attained given the varying levels of compaction in driveways, roads, etc. the maximum depth attainable will be documented in the field logbook and on the field sample data sheet (FSDS).
- Record semi-quantitative estimate of VV observed as described in Section 5.3.
- Replace soil and cover material.
- Repeat as necessary employing procedure outlined above.

<u>CUA and LUA Zones:</u>

- Using a spade or trowel, carefully removing organic material, including grass, from the surface of the soil. Remove and visually inspect soil to a depth of 0-3 inches below ground surface[6].
- Record semi-quantitative estimate of VV observed as described in Section 5.3.

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[4] Surface Inspections- The non-intrusive visual inspection of the immediate surface of a zone was eliminated from a previous iteration of this SOP after their data were reviewed and determined by the EPA to provide no additional information over that gained through Point Inspections.
[5] A soil depth of 6 inches for SUAs was chosen to approximate the depths to which digging would be expected during typical activities occurring in these SUA zones (e.g., gardening, child digging in dirt).
[6] A soil depth of 3 inches was chosen to approximate the depths to which soil disturbance would be most likely during typical activities occurring in these CUA and LUA zones (e.g., lawn mowing).

- Carefully replace all soil and organic material.
- Repeat as necessary employing procedure outlined above.

PB, SB, and SS Zones:

- Move items as necessary to access the soil surface.
- Using a spade or trowel, remove and visually inspect soil to a depth of 0-3 inches below ground surface[7].
- Record semi-quantitative estimate of VV observed as described in Section 5.3.
- Repeat as necessary employing procedure outlined above.

If during the PI, VV is observed to be localized within a zone, the portion with vermiculite will be denoted on the field sketch. If additional PIs are necessary to determine the boundaries of the area, approximately 10 to 20% additional PIs will be evaluated to determine the extent of localized vermiculite.

5.3 Semi-Quantification of Visual Vermiculite

During a PI, the field team will estimate the quantity of vermiculite observed. Each PI location for all zones will be assigned a semi-quantitative estimate of visible vermiculite content using a 4-point scale: none (blank), L, M, and H[8]. For PI locations where VV is observed, semi-quantitative estimates (e.g., L, M, or H) will be recorded on the field sketch. PI locations where VV is not observed will not be recorded on the field sketch. Photographs illustrating these quantities are attached to this procedure as Figure 2.

6.0 Health & Safety/Engineering Controls

All personnel will carry out visual inspections in accordance with proper personal protective equipment (PPE) and other monitoring/governing requirements outlined in the current version of the Accident Prevention Plan governing the work being conducted.

All visual inspections will employ appropriate engineering controls to minimize dust (e.g., wetting soil during inspection) as prescribed in the current version of CDM-LIBBY-05 (30-point Composite Sampling of Surface Soil for Asbestos).

7.0 Equipment Decontamination

Equipment decontamination is not required between each PI from the same zone, but is required before moving to another inspection zone. Decontamination of equipment will be conducted as required by the governing document referencing this procedure.

[7] A soil depth of 3 inches was chosen to approximate the depths to which soil disturbance would be most likely during typical activities occurring in these PB, SB, and SS zones (e.g., entering crawlspace, retrieving items from shed).

[8] Based on the EPA's review of previous data, the 5-level scale VV identification scheme was not meaningful and has been reduced to a 4-level scale. As such, the semi-quantitative estimation "Gross" VV in a previous iteration of this procedure was combined with "High" estimations. Previously collected data of Gross VV should be considered analogous to High VV under this revised procedure.

8.0 Documentation

As noted above, information about the presence of vermiculite will be recorded on the field sketch for the property under investigation. Each zone will be marked with:

- Zone type (i.e., SUA, CUA, LUA, PB, SB, SS, or NUA)
- Semi-quantitative estimate of VV content for each PI (i.e., L, M, H)

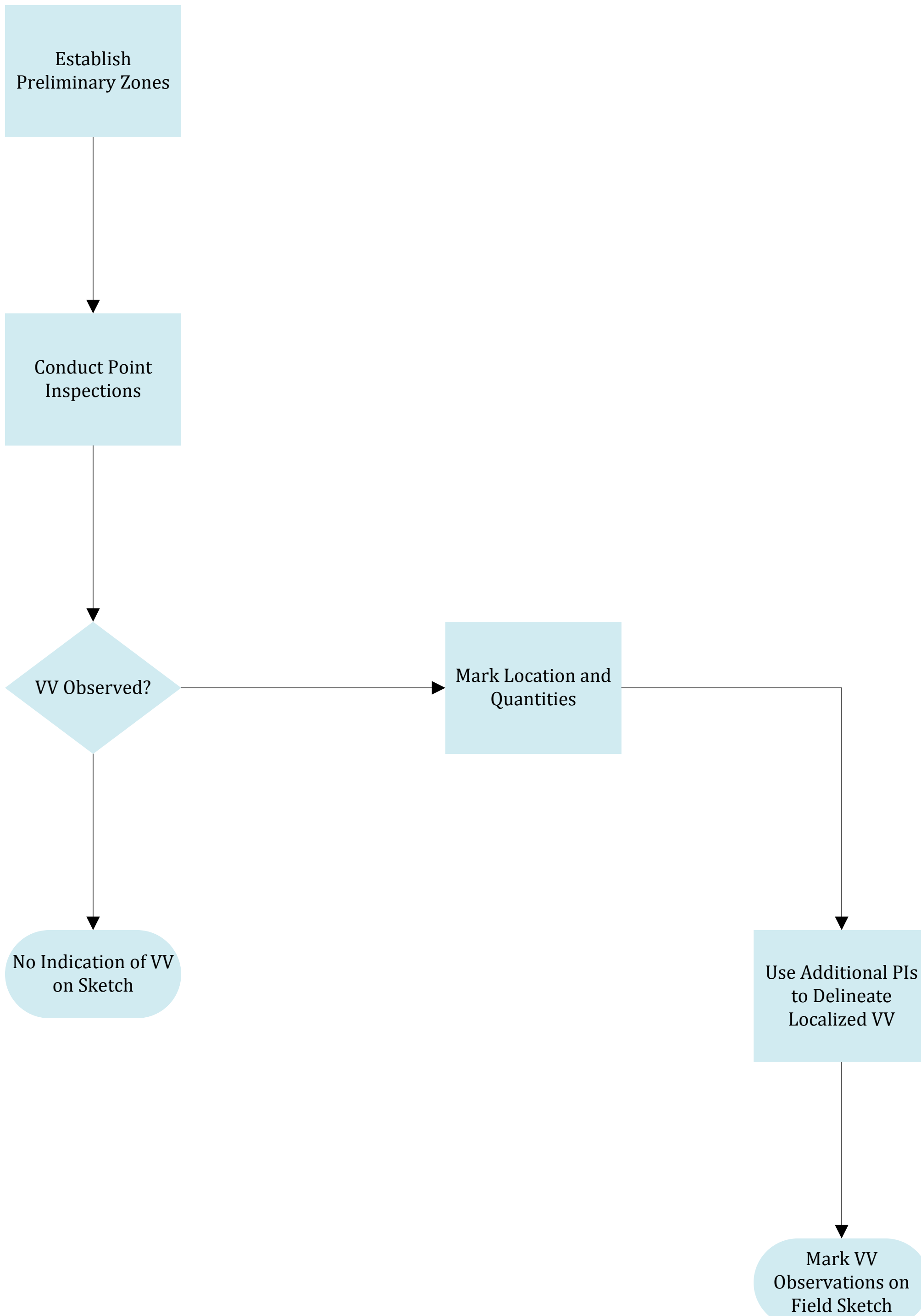
In addition to field sketch documentation, each field team will document the semi-quantitative visual estimates of VV on the FSDS for each zone. If material other than vermiculite was observed during the inspection (e.g., tremolite, mine tailings, micaceous minerals), the specific location and material observed should be noted on the field sketch and recorded in the visible vermiculite comment field on the FSDS. The FSDS will be managed according to governing guidance documents.

9.0 Quality Assurance/Quality Control

Every effort will be made to maintain consistency in the semi-quantitative evaluation of VV in soil. Quality assurance/quality control processes and measures will include training; use of specimen examples (e.g., jars/photographs of low, intermediate, and high quantities of vermiculite); use of designated field staff; and oversight by the FTL. Figures illustrating none, low, intermediate, and high quantities of vermiculite are attached to this procedure for reference (Figure 2).

To maintain consistency over time, the FTL will verify semi-quantitative assignments at a rate of one zone per team per week, or at the rate specified in the governing document referencing this procedure. The FTL will sign off on those field sketches that were verified. If inconsistencies are noted, the FTL will hold re-training with all teams participating simultaneously. Updates to this procedure and its attached specimen examples will occur as necessary and the EPA will be notified when these updates are recommended by FTL or field investigation manager.

Figure 1
Inspection Process



Revised 02-12-13

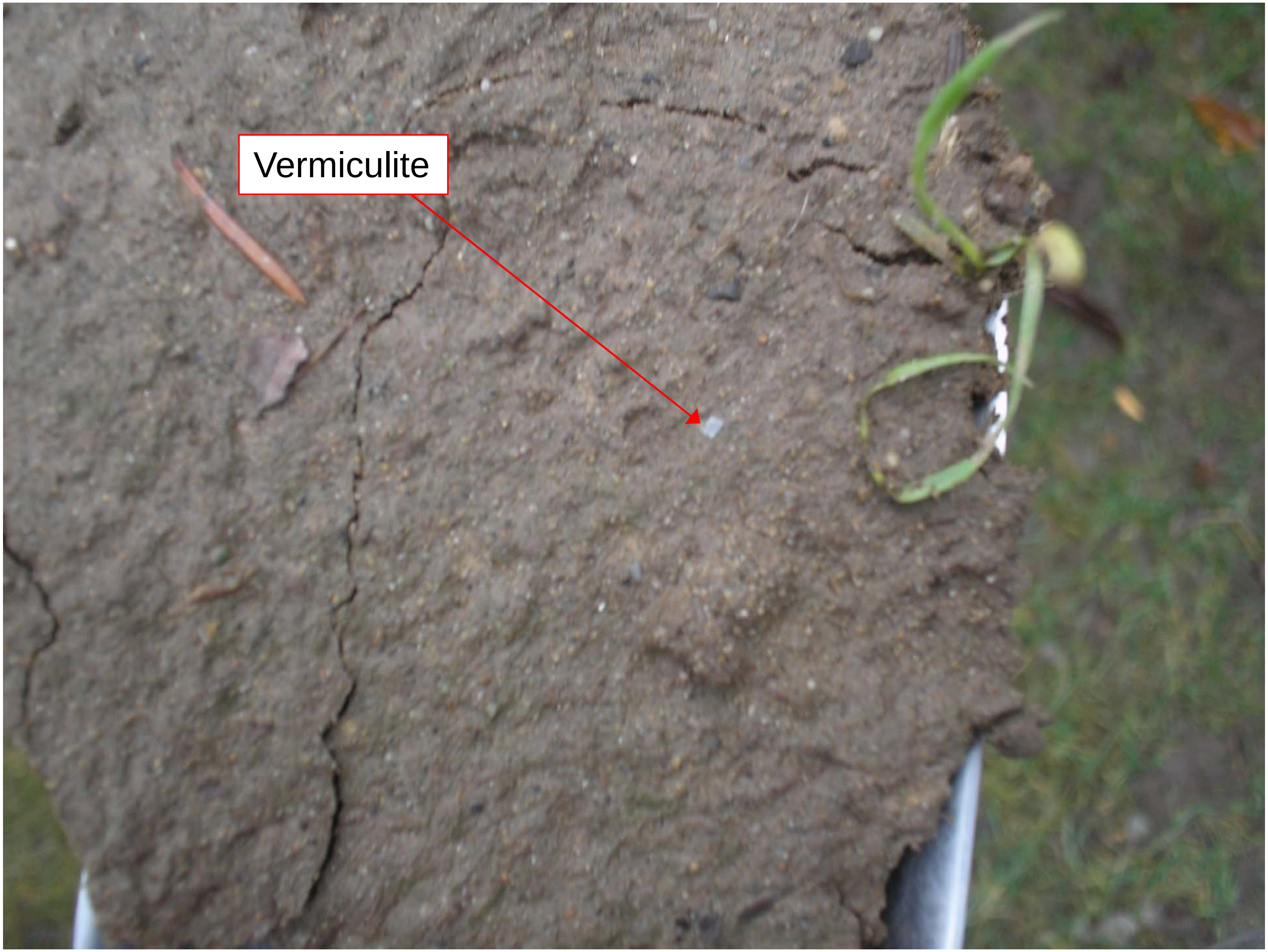


Figure 2a: *Low Visible Vermiculite* – A maximum of a few flakes of vermiculite observed within a given visual inspection point

Figure 2b: *Medium Visible Vermiculite* – Vermiculite easily observed throughout visual inspection point, including the surface.

Figure 2c: *High Visible Vermiculite* – Visual inspection point contains Approximately 50% (or greater) vermiculite by volume

Libby Asbestos Superfund Site
Site-specific Procedure
GPS Coordinate Collection and Handling

Prepared by: Diane M Rode Date: 5/3/12
CDM Smith

Reviewed by: ________ Date: 5/3/12
CDM Smith Technical Reviewer

Reviewed by: ________ Date: 5/3/12
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	5/21/07	--
1	--	Not finalized/approved
2	7/27/09	Updated to align processes with current GPS collection equipment, and data management processes and requirements
3	4/24/12	Updated to align processes with current GPS collection equipment, and data management processes and requirements

1.0 Objective

The objective of this site-specific procedure is to establish baseline requirements, procedures, and responsibilities for collecting and handling global positioning system (GPS) data by the U.S. Environmental Protection Agency (EPA) or its contractors related to investigations conducted at the Libby Asbestos Superfund Site (Libby Site). This procedure describes the equipment and operations to be used for collection of location coordinate data. Additions or modifications to this procedure may be detailed in governing documents referencing this procedure.

2.0 Background

2.1 Definitions

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Libby YYMMDD.ddf Data Dictionary – The filename for the Libby data dictionary contains the date of the latest revision in the format YYMMDD. All Trimble handheld units used at the Libby Site should come with a generic data dictionary that handles collection of lines, points, and areas. In addition, the Trimble units will be uploaded with the Libby data dictionary by a designated onsite administrative support or data management staff. The Libby data dictionary is specific to the spatial data collection needs for the Libby Site, which are guided by EPA data reporting requirements. For all locations assigned during investigation and soil excavation, a latitude and longitude coordinate representing the location will be required. All personnel required to collect GPS data will be familiar with the contents of the Libby data dictionary.

Scribe – An EPA data management system used manage location, sample, and analytical data.

2.2 Discussion

The following attributes are required to be collected, as indicated in Table 1, for each feature type when a GPS coordinate is collected:

Table 1 – Attributes Collected in the Libby_YYMMDD Data Dictionary

Feature	Attributes Collected
Any Location	LocationID
BD Location	LocationID
SP Location	LocationID
XX Location	LocationID

These features are discussed in detail in Section 4.0 of this document. Instructions for loading a data dictionary onto a datalogger is discussed in Section 4.3.

3.0 Responsibilities

Team Leader (TL) – The TL is responsible for overseeing the GPS point collection process for their field teams, ensuring field team members are adequately training in this procedure, and coordinating with onsite data management staff to ensure completeness of the GPS dataset required to be collected (as specified in the governing document referencing this procedure).

Field team members – Field team members are responsible for collecting GPS data, as specified in the governing document referencing this procedure, and reporting any data collection issues to the TL.

Designated administrative support staff – This staff is responsible for the successful transfer of GPS data from field equipment to the onsite server.

Onsite data management staff – This staff is responsible for coordinating with offsite GIS staff (see below) and publishing finalized GPS data to Scribe. This staff will also support the TL in ensuring the completeness of the required GPS dataset for each field activity.

Offsite geographic information system (GIS) staff – Designated offsite GIS staff is responsible for processing GPS data and returning the data to onsite data management staff. The procedure for processing GPS data is provided in the Libby Field eRoom at: https://team.cdm.com/eRoom/R8-RAC/Libby/0_aeaa.

4.0 Procedures

The following sections describe how GPS points are collected and handled for features commonly used at the Libby Site.

4.1 GPS Point Collection

All features collected at the Libby Site are point features. The Libby Any Location feature will allow any 9 digit text value which will correspond to the Location ID assigned on the field sample data sheet (FSDS). For ease and accuracy of data entry of location values, three additional location features are available for which the Location ID attribute defaults to the values "BD-", "SP-" or "XX-" accordingly. The prefix code values are determined by the guidance document governing the field work.

Building Locations

For building locations, a point is collected near the front door or main entrance of the building. Refer to the governing document for details regarding building location types.

Locations Where No Sample is Collected

For investigation locations where a sample is not collected, a GPS point is collected at the approximate center of each location area, or as specified in the governing document referencing this procedure.

Soil Sample Locations

For grab sample locations, a GPS point is collected at the exact sampling location.

For composite sample locations, a GPS point is collected at the approximate center of the sample area. In the case of an irregular-shaped sample area or sample area that is non-continuous (e.g., a flowerbed that wraps around a house), a GPS point is collected at the center of the largest continuous sample area.

A GPS point is collected once per unique sample location. All subsequent samples taken at that location (including field duplicate samples) will use the previously assigned Location ID and corresponding X,Y coordinates.

Outdoor Stationary Air and Dustfall (Settled Dust) Samples

For permanent outdoor stationary air and dustfall sample locations (i.e., those representing a consistent monitoring zone or area, and are collected on a routine schedule), a GPS point is collected once per unique sample location. All subsequent samples taken at that location use the previously assigned Location ID and corresponding X,Y coordinates.

Interest Point, Interest Area

GPS points for interest point and interest area features are not routinely collected on the Libby Asbestos Project. However, they are included in the Libby data dictionary in the event that a GPS point or a series of points is collected to document the perimeter of an interest area or sample area or other point that does not correspond to a location in the Scribe database.

Pre-determined Sample Areas

For pre-determined sample areas (e.g., gridded) where waypoints are available, the Trimble units may be pre-loaded with waypoint files to guide samplers to sampling locations. Pre-loading of coordinates is typically performed by a member of the Libby information management system team or by the field team leader. It should be noted that, in order to ensure GPS coordinate data are included in the project database, *GPS points will also be collected at the time of sampling for sample locations located using waypoint files*.

Features Not Requiring GPS Points

GPS points are not collected for the following features, unless otherwise specified in the governing document referencing this procedure:

- Stationary air, dust, and soil samples collected inside or beneath buildings (these locations are associated with the X,Y coordinate of the building where the sample was collected)
- Stationary air samples, with the exception of permanent monitoring locations as designated in site-specific removal work plans or Response Action Work Plan Addenda
- Duplicate or Replicate air or dust samples (which are assigned the same Location ID and X,Y coordinates as the parent sample)
- Soil samples taken at depth from the same sample area as a previously-collected sample. The at-depth soil sample will be assigned the same Location ID as the shallower sample in order to relate both samples to the same X,Y coordinate.
- Duplicate or split soil samples (which are assigned the same Location ID and X,Y coordinates as the parent sample)
- Personal air samples (locations are associated with the X,Y coordinate of the building (i.e., BD Location ID) or property (i.e., AD Location ID) where the sample was collected)

4.2 Operation of Trimble Handheld Units

Operators must be standing at the sample location before the unit starts to collect positions. Once the unit has started collecting positions, the operator must remain standing at the sample location until the minimum required positions have been collected. A minimum of 30 positions will be collected for each GPS location. More positions may be required in circumstances where the position dilution of precision (PDOP) is greater than the default setting of 4.5.

Record-keeping Requirements

Serial numbers of the Trimble datalogger, receiver, and antenna or beacon will be recorded in a field logbook. GPS filenames will be recorded in the logbook. Recording GPS filenames on field sample data sheets (FSDSs) is not required.

Upgrades to Trimble Equipment and Software

Trimble equipment and software is subject to change according to availability. The TL or designee is responsible for contacting the technical support of the vendor if there are any questions regarding setup, operation, or data transfer of models not covered below.

Data Collection Instructions for Trimble GeoXH

Note: the datalogger and beacon have a wireless Bluetooth connection that must be in place before collection of coordinate data.

Follow these steps to collect GPS points:

1. Turn on the datalogger by pushing the green button.

2. From the start menu open TerraSync.

3. Turn on the beacon by pushing the green “on” button. The battery light should be a steady green, the middle Bluetooth light should be slowly flashing blue and the tower light should be flashing green when connected to the datalogger correctly.

If the Bluetooth light is not flashing or not blue, check the connection as follows:

4. From the Start menu select Settings.

5. From the bottom of the menu select Connections.

6. Select Bluetooth. In the Mode tab make sure the Turn on Bluetooth is selected.

Once a connection has been established, from the datalogger:

7. Select Data from the upper left drop down menu in Terra Sync.

8. Name the file using the following naming convention: T1A102012, where “T1” refers to the specific Trimble unit being used, “A” refers to the first file of the day (“B” would be the second file of the day, and so on), and “102012” refers to the date (October 20, 2012).

9. Scroll down and make sure the data dictionary is set to the Libby data dictionary.

10. Select Create.

11. Confirm the antennae height by selecting Ok.

12. Highlight the appropriate feature name and select Create. The unit will begin logging the point automatically if the connection status is valid. Enter the attribute data using the stylus and the keyboard icon located at the bottom of the touch screen. When recording is complete, select Ok, which saves the file and location information.

13. To collect other points within the same feature file, select the Options menu then select Repeat.

Data Collection Instructions for Trimble ProXRS

Follow these steps to collect GPS points:

1. Turn on the Trimble unit.

2. Select Data Collection from the main menu.

3. Select Create New File and press Enter. A generic default file name that begins with “RO…” followed by the date will appear.

4. Name the file using the following naming convention: T1A102012, where “T1” refers to the specific Trimble unit being used, “A” refers to the first file of the day (“B” would be the second file of the day, and so on), and “102012” refers to the date (October 20, 2012). For older models with an 8-character restriction, drop the leading T from the filename.

5. Make sure the data dictionary is set to the Libby data dictionary.

6. Press Enter to bring up the Start feature menu.

7. Arrow to the feature to be collected Press Enter.

8. Press the F1 key to pause the unit until data collection can begin. (Note that if the unit is not paused, data collection will begin immediately).

9. Enter the Location ID exactly as it appears on the printed labels. (Note that Location IDs must match field documentation).

10. Capitalize the ID prefixes where they are capitalized, include dashes where they are present, and remove extra spaces. (Note that data entry errors will prevent the coordinate data from exporting and validating correctly).

11. Press the F1 key to resume collecting positions. The unit will beep for every position it collects, and display the total number of positions in the lower right corner.

12. After the counter has reached the desired number of positions (30 positions), press Enter and then Enter to confirm and save your data point.

13. Repeat this process for every new sample location.

Data may be viewed and edited by pressing F2 (Review) from the Start feature menu, using the directional pad to scroll through the locations and pressing Enter to view the sample information. If edits are made to the data, be sure to press Enter. To exit without changing the data press Esc. Press F2 (New) to return to the Start feature menu.

Additional handheld features
<u>Review feature</u> – allows for quick review/editing of keyed data.

<u>Repeat feature</u> – use of this feature is not advised because of the likelihood to miss an edit of the index or location id fields. Points that have not been edited correctly will be rejected as duplicates when they are uploaded.

<u>Offset</u> – reduces the extra time associated with trying to capture GPS data under bridges, large trees, porches, facades and awnings, or while standing close to a building or other object that can deflect satellites signals from the GPS receiver.

<u>Delete Feature</u> – allows for deleting a feature from a file if, for example, no positions were collected or the sample is voided. This will prevent having to rectify data later on.

<u>Rename File</u> – allows for file name browsing/editing. This will prevent having to rectify data if done before the files are downloaded.

<u>Delete File</u> – allows for deleting a file from the handheld when necessary. This will prevent having to rectify data if it is done before the files are downloaded.

Data Collection Instructions for Trimble GeoXT

Follow these steps to collect GPS points:

1. Turn on the unit and using the stylus, select GPS from the lower right menu. This will open the Terra Sync software.

2. Wait for the GPS status screen to recognize at least 4 satellites. Depending on location, this can take several minutes and must be complete or data will not successfully be collected. The connected satellite names will appear on the left side of the screen – highlighted to indicate a connection.

3. Select Data from the upper left drop down menu. Use the file naming convention described above to create a file. Make sure the data dictionary is set to the Libby data dictionary. Select Create.

4. Confirm the antennae height by selecting Ok.

5. Highlight the appropriate feature name and select Create. The unit will begin logging the point automatically. Enter the attribute data using the stylus and the keyboard icon located at the bottom of the touch screen. When recording is complete, select Ok, which saves the file and location information.

6. To collect other points within the same feature file, select the Options menu then select Repeat.

4.3 GPS Data Transfer from Handheld Units to Lbysvr1

GPS File Transfer to Lbysvr1 from Trimble Pro XRS

1. Turn on the Trimble unit. (Note that the unit will try to connect to the GPS receiver - press the Esc button).

2. Select File Manager.

3. Select File Transfer - *currently the data consists of .ssf files and is transferred to\\Lbysvr1\Projects\Data Management\Pfdata\Libby*

4. Open Pathfinder Office.

5. Select Utilities.

6. Select Data Transfer.

7. Select Add.

8. Select Datafile (Note that Pathfinder will search for a connection to the Trimble Unit).

9. Connect the cable from the computer to the Trimble unit. A list of files will appear when the connection is complete.

10. Select Open.

11. Select Transfer All.

12. When the download is complete, close the data transfer window. If downloading files from several units, close and reopen this window between downloads.

13. Delete files from the Trimble unit (all of the files will be listed). Double check that all the files were transferred to libbysvr1 before deleting.

GPS File Transfer to Lbysvr1 from Trimble Pro GeoXT or GeoXH

The Trimble GeoXT or GeoXH connects to a personal computer (PC) through the charger unit using a universal serial bus (USB) cable (type A to type B*)*, and Microsoft Active Sync software. (Note that there are Active Sync connection settings to enable or disable once the device is connected to the PC. From the Active Sync menu, select Tools, select Options. These connect the Trimble to other Windows applications on the PC (e.g., email, task managers, etc.). The main reason to disable these settings at the Libby office is that the Trimble units are shared and it does not make sense to activate them.)

1. Turn on the Trimble Unit.

2. Open Terrasync.

3. Select Data.

4. At the bottom of list, select File Manager.

5. Open Pathfinder.

6. Select Utilities.

7. Select Data Transfer. The receive tab should be active.

8. From the Device list, select GIS Datalogger on Windows CE.

9. Click on the connect icon (the button with the checkmark circled in green). A picture on the right will indicate the connection status.

10. Select Add

11. Select Open (make sure all files are highlighted)

12. Select Transfer All.

Note: To load a data dictionary onto the datalogger, from step seven, select the send tab. When adding the file, navigate to the file you wish to load onto the datalogger. Make sure the file is highlighted before selecting transfer all.

4.4 GPS Data Processing

Following the download of files from the Trimble units, a copy of each file is made and filed in *Lbysvr1\ Projects\Data Management\Pfdata\Libby\RawFiles*. The raw files are not modified but kept as the only copy of the original downloaded data files. The files are zipped and sent off site by onsite data management staff for processing by offsite GIS staff. Finalized, processed GPS data are then returned to onsite data management staff who import and publish the data to Scribe.

4.5 Equipment, Software, and Configuration

Software can vary with rental equipment; however, the preferred software for collecting GPS data is GPS Pathfinder Office and TerraSync. The table below contains guidelines for configuration settings (based on TSC1 5.27 software), that should be implemented for GPS point collection. (Note that some GPS Pathfinder Office and TerraSync settings can be changed to accommodate data collection needs).

Table 2. Configuration Settings for Trimble ProXRS

GPS Rover Options - Logging Options		
Logging Intervals	Point feature	1 s
	Line / area	3 s
	Not in feature	none
	Velocity	none
Confirm end feature	no	
Minimum Positions	30	
Carrier phase	Carrier mode	off
	Minimum time	10mins
GPS Rover Options – Position Filters		
Position mode	Manual 3D	
Elevation mask	15 degrees	
SNR mask	6.0	
DOP type	PDOP	
PDOP mask	6.0	
PDOP switch	4.0	
GPS Rover Options – Real-time input		
Preferred correction source	use uncorrected GPS	
GPS Rover Options – General real-time settings		
Correction age limit	10s	
GPS Rover Options – Antenna options		
Height	Set according to model	
Measure	Vertical	
Confirm	Never	
Type	auto-filled when part number is entered	
Part number	get part number off of antenna	
GPS Rover Options – Initial Position		
North	USft	
East	USft	
GPS Rover Options – 2D altitude		
Altitude(MSL)	USft	
Computed at	time	
Computed at	date	
GPS Base Station Options – Logging Options		
Logging Intervals	Measurements	5s
	Positions	30s

Audible Click	Yes	
Log DOP data	Yes	
GPS Base Station Options –	**Position Filters**	
Position mode	Manual 3D	
Elevation mask	15 degrees	
SNR mask	4.0	
PDOP mask	6.0	
PDOP switch	4.0	
GPS Base Station Options –	**Real-time output options**	
Real-time output mode	off	
Radio type	Custom	
Baud rate	9600	
Data bits	8	
Stop bits	1	
Parity	Odd	
RTCM options	Station	1
	Message type	Type 1
	Message interval	5s
	Message suffix	None
	CTS flow control	Off
	CTS xmit delay	0ms
	RTS mode	High
	RTS edge delay	0ms
GPS Base Station Options –	**Reference position**	
Datum	WSG 1984	
Zone	11 North	
NMEA/TSIP Output options		
Output	TSIP	
Baud rate	38400	
Coordinate System	Latitude/Longitude	
Map display options	All show with no background	
Units and Display		
Units	Distance(2D)	US Survey Ft
	Area	Square feet
	Velocity	Miles/Hour
	Angle format	DDMMSSss
	Order	North/East
	North reference	True
	Magnetic declination	Auto
	Null string	
	Language	English
Time and Date	24 hour clock	Yes
	Time	##:##:##
	Date format	MM/DD/YYYY
	Date	MM/DD/YY weekday
Quickmarks	Attributes	Repeat
	Confirm	No

Libby Asbestos Superfund Site
Site-specific Procedure
Crawlspace Entry

Prepared by: ______________________ Date: 2/18/13
CDM Smith

Reviewed by: ______________________ Date: 2/18/13
CDM Smith Technical Reviewer

Reviewed by: ______________________ Date: 2/18/13
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	2/18/2013	--

1.0 Objective

The objective of this procedure is to establish baseline requirements, procedures, and responsibilities for entering crawlspaces, including spaces under mobile homes (i.e., trailers). This procedure discusses safe entry practices as well as the requirements for atmospheric monitoring while conducting crawlspace inspections and/or sampling. This procedure shall apply to all crawlspaces being entered by CDM Smith staff on residential, commercial, public, and industrial properties within the Libby Asbestos Superfund Site (site) for the purpose of general property investigation activities.

2.0 Background

2.1 Definitions

Atmospheric conditions monitoring – For the purposes of this procedure, atmospheric conditions monitoring will consist of drawing air through a four-gas meter, observing the results that the meter displays, and conducting the appropriate actions based on the results. Atmospheric monitoring will also include the documentation of the data gathered in the appropriate location.

Attendant – The attendant is responsible for outside support during the entire time that the entrant is inside the crawlspace.

Crawlspace – For the purpose of this procedure, a crawlspace is any space underneath a structure that can be physically entered, typically in order to perform an inspection and/or conduct soil sampling during general property investigation (GPI).

Entrant – The entrant is responsible for physically entering the crawlspace and performing investigation activities.

Job hazard analysis (JHA) form – Form used to identify and document worksite-specific hazards or potential hazards.

Lower explosive limit (LEL) - The LEL is the minimum concentration of vapor in air below which propagation of a flame does not occur in the presence of an ignition source.

Libby Asbestos Superfund Site (site) - All buildings and land within the boundaries of each operable unit (OU) of the site as illustrated on the most recent version of the OU boundary map.

2.2 Discussion

Crawlspace entry at the site generally consists of physically entering a space, visually inspecting the soil inside the space, collecting a soil sample if necessary, and conducting photo documentation.

Atmospheric conditions monitoring consists of the active monitoring of the concentrations of various gases within the space that is to be entered. Atmospheric monitoring shall be used to determine the conditions within the space in order for personnel to make appropriate decisions on whether to enter a crawlspace and proceed with investigation activities.

3.0 Responsibilities

Successful execution of this procedure requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for entering crawlspaces will understand and implement the requirements contained herein, as well as any additional requirements stated in the governing document.

Field Team Leader (FTL) - The FTL is responsible for overseeing crawlspace entry processes as described in this procedure and specified in the governing document referencing this procedure. The FTL will communicate with field team members regarding specific investigation objectives related to crawlspaces, and anticipated situations that may require deviation from this procedure. It is also the responsibility of the FTL to communicate the need for any deviations from the procedure with the appropriate client personnel, and document approved deviations using a Libby Asbestos Project Field Record of Modification Form as referenced in the governing document referencing this procedure.

Field Team Members – Field team members (e.g., GPI staff) performing crawlspace entry are responsible for adhering to the steps contained in this procedure. The field team members should have limited discretion with regard to entry procedures but should exercise judgment regarding health and safety concerns for each individual crawlspace, as all spaces present unique hazards. Field team members are also responsible for promptly communicating any consistent problems (e.g., equipment failure, problems with bump testing equipment) to the FTL for the purpose of troubleshooting and information sharing with other field team members.

Health and Safety (H&S) Team Members – H&S team members are responsible for segregating and labeling improperly functioning four-gas meters, assisting in meter repairs or returns to the lender or manufacturer, and communicating with the FTL to ensure the proper number of meters is available to support field efforts.

4.0 Required Equipment

- Four-gas meter – Battery powered four-gas meter, such as a Ventis MX4 four-gas meter or equivalent, used for monitoring atmospheric conditions. For the purposes of site crawlspace entry, the following will be measured: levels of oxygen (O_2), hydrogen sulfide (H_2S), and carbon monoxide (CO), and the LEL.

- Sampling probe – Telescoping sampling probe constructed from a standard air sampling pump stand. Sampling probes are constructed to allow a length of tubing to be attached (wire ties are appropriate) so that the field team member may place the tubing a specific distance away from him/her. Probes shall be approximately 4.5 feet in length.

- Inert tubing – Tubing provided by the four-gas meter manufacturer to allow the field team member to collect air from various distances from him/her and observe the atmospheric conditions displayed on the four-gas meter from a remote location. Tubing shall be approximately 4.5 feet in length.

- Pre-filter – A pre-filter shall be attached to the end of the tubing to prevent debris/moisture from entering the tubing and/or four-gas meter.

- Approved calibration gas – Calibration gas will be used to bump test each four-gas meter before it is used in the field as well as for monthly calibration of the four-gas meter. Calibration shall use a 29-liter metal cylinder and regulator. The calibration gas concentrations are as follows:

  - Hydrogen sulfide (H_2S) – 25 parts per million (ppm)

  - Carbon monoxide (CO) – 100 ppm

  - Pentane – 0.35%

  - Oxygen (O_2) – 19%

  - Nitrogen – Balance

- Tedlar bag – A tedlar bag will be filled with calibration gas and used for calibration and bump testing.

- Electrical tester – Staff conducting crawlspace entry shall carry an electrical tester to determine whether wiring encountered during investigation activities is energized. Electrical testers shall be non-contact voltage testers, which do not require actually contacting wiring to test whether the wiring is energized.

- Two-way radios – Staff conducting crawlspace entry shall carry two-way radios so that the entrant may communicate with the attendant while inside the crawlspace.

- Modified level C personal protective equipment (PPE) – Modified level C PPE will be used by all staff conducting crawlspace entry for investigation activities.

- Various investigation equipment – Other investigation equipment that may be used during crawlspace entry, as specified by the governing document referencing this procedure.

5.0 Procedures

Prior to conducting work at any Libby worksite, health and safety procedures, as specified in the governing health and safety plan will be reviewed and the appropriate PPE donned.

5.1 Bump Testing of Four-gas Meter

Before mobilizing to any worksite, the team shall first "bump test" a four-gas meter. Bump testing will follow manufacturer's instructions using supplied, approved calibration gas and a tedlar bag. The bump test shall be documented on the field team's worksite-specific JHA form before the form is taken into the field. The instructions for bump testing are as follows:

1. Turn the meter on and wait for the meter to reach the home or gas monitoring screen. The meter will proceed through a warm-up process, which takes about 25-30 seconds.

2. Fill the tedlar bag with calibration gas. This can be accomplished by attaching the regulator to the calibration gas cylinder, then attaching the tedlar bag to the fitting on the cylinder. Both valves must be opened to fill the bag. First open the valve on the bag (approximately one full turn), then the valve on the regulator (approximately one full turn). The bump test process can be completed by filling the tedlar bag approximately half full of calibration gas. After the tedlar bag contains the appropriate amount of gas, close the valve on the regulator first, followed by the valve on the tedlar bag. Note that the calibration gas shall not be taken into the field for any reason and shall remain in the CDM Smith office.

3. Zero the four-gas meter by pressing the power button twice from the home or gas monitoring screen. A zero with a slash through it will appear in the top left-hand corner of the display. Press enter, the meter will begin the zeroing process and emit an audible "beep" when it has finished the zeroing process.

4. Begin the bump test procedure by pressing the power button three times from the home or gas monitoring screen until the bump test screen is displayed. This is identifiable by the "bt" at the top left-hand side of the screen, then press the enter button. The expected bump test values will begin to flash. From this screen, the meter will allow five minutes to apply the calibration gas.

5. Apply the calibration gas. This can be accomplished by opening the valve on the tedlar bag approximately one full turn. Do not apply the calibration gas to the meter without first opening the valve on the tedlar bag as this can cause damage to the meter.

6. The four-gas meter will then begin to pull the gas from the tedlar bag and begin to read values for all four gases. It will also emit an audible alarm, this is normal. If the meter has passed the bump test, a letter "P" will appear in all four corners of the display where gas values would normally be displayed. If the meter fails the bump test, a letter "F" will appear in all four corners of the display. If a meter should fail a bump test or there are other issues with completing the bump test, notify the FTL. **Do not use the meter.**

7. Upon notification by the FTL that a meter has failed a bump test or is otherwise problematic, a member of the H&S team will take the unit out of service and clearly tag the unit as such until it can be fixed or replaced. The H&S team will work with the FTL to ensure the proper number of functioning meters is available for field team use.

8. Following successful completion of the bump test, the field team may proceed to use the four-gas meter in the field.

5.2 Crawlspace Pre-entry

Upon arrival at the worksite, the field team shall complete their required pre-investigation paperwork (e.g., logbook, JHA). Following the completion of the pre-investigation paperwork, crawlspaces requiring entry shall be identified. If more than one crawlspace hatch or access is available for entry, both hatches/accesses shall be opened and fresh air allowed to enter the space for no less than 5 minutes. Prior to removing the hatches or access panels photographs shall be taken of the hatches to note pre-existing conditions.

During this ventilation period, the field team should take note of any unsafe conditions at the property, such as leaking propane tanks, any odors of sewer gases, issues with structural integrity, etc. If any of these conditions are present, the specific condition shall be documented on the JHA and field staff **shall not enter** the crawlspace. Field staff will then notify the FTL and document the situation in the logbook and in photographs (as applicable). Copies of all field documentation shall be placed in the appropriate property folder for reference.

If no unsafe conditions are noted during the crawlspace ventilation period, the entrant will don modified level C PPE (refer to the governing health and safety plan) and prepare to proceed with crawlspace entry. At this time the entrant shall have the four-gas meter turned on (successfully bump tested offsite) and have ready the sampling probe (with tubing attached using wire ties) with the pre-filter already attached to the tubing.

The entrant shall also reset the peaks and lows function on the meter prior to entry. This can be accomplished by completing the following steps:

1. From the home or gas monitoring screen, press the power button four times until four values are displayed (these values will likely be from the bump test earlier in the day) and there is a line graph with an arrow in the top right-hand corner.

2. To reset these values, simply press the enter button once and the values will be reset.

5.3 Crawlspace Entry

During the crawlspace entry, there shall be at least two team members present at the worksite: one to serve as the entrant and one to serve as the attendant.

Note: At no time during the entry should the attendant leave the access to the space unattended. The attendant shall remain at the access point until the entrant is finished with all investigation activities and exits the crawlspace.

The steps below will be followed for crawlspace entry:

1. If for any reason after the team is onsite to complete an inspection and the team's four gas meter is malfunctioning, the team shall contact the FTL and explain the situation. The situation shall be discussed between the field team and the FTL. If a properly functioning four gas meter cannot be procured then the field team and field team leader will decide how to proceed with inspection.

2. Prior to entering the space, the entrant will use a bump tested four-gas meter to collect background readings near the access to the space. If readings are within accepted values (O_2 – 19.5-23.5%, H_2S – <5 ppm, CO – <15 ppm, LEL – 0%) the entrant may proceed to attach the tubing from the end of the sampling probe to the four-gas meter. This can be accomplished by attaching the tubing from the sampling probe to the inlet of the four-gas meter. The inlet is located on the top of the meter. At this time the entrant shall have the sampling probe fully extended and prepared for use.

3. The entrant shall first place the probe just inside the access point and observe the readings. If readings appear to be normal, the entrant may enter the space. If the readings are not normal and/or the meter begins to alarm, the entrant **shall not enter** the space and shall notify the FTL and document the observed readings on the JHA

Note: While using the probe in the space to monitor gases, it takes approximately 1 second per 12" for the gases to travel through the tubing and back to the meter.

4. The entrant may now remove the tubing from the meter and proceed to enter the space. The entrant can carry the meter with them throughout the inspection unless circumstances arise that are described in 5.3.6 of this SOP. After the entrant is inside the space, the entrant shall proceed with caution, observing exposed electrical wires, changes in grade, standing water, leaking plumbing, odors through their respirator, and biological hazards. If while inside the space the entrant observes elevated values of LEL, H2S, CO or a change in oxygen levels, they should move away from that area until the atmospheric conditions return to expected values.

5. While inside the space, the entrant shall use their two-way radio to communicate with the attendant regarding crawlspace conditions and hazards that may exist.

6. If while inside the space the entrant encounters a change in grade such as a drop or rise of any distance of three feet or more, the entrant shall use the sampling probe to test the atmosphere at the lower or higher level. The purpose of this additional testing is due to the fact that gases have different densities and will rise or fall to certain areas.

7. The entrant shall also carry an electrical tester with them while conducting investigation activities. Project-provided testers do not require entrants to actually touch wires to

determine whether they are energized. If wiring is discovered during the investigation activities, the entrant shall take precautions to avoid the wiring, as well as any electrical equipment.

Note: In general, entrants shall treat all wiring as though it is energized.

8. The entrant shall monitor the four-gas meter as it detects gases throughout the duration of the entry. If at any time the meter alarm sounds, the entrant shall exit the space as quickly as possible. The entrant shall also notify the attendant so they are aware of the situation inside the space. Once outside the space, the field team shall document the situation in the JHA and in their logbook. The field team shall then proceed to notify the FTL as well as a member of the H&S team.

5.4 Crawlspace Post-entry

After crawlspace investigation activities have been completed, the entrant shall proceed to the access point of the crawlspace and complete the equipment and personal decontamination process. Equipment decontamination will be performed in accordance with EPA-LIBBY-2012-04, *Field Equipment Decontamination.* The investigation team shall collect photographs of the final conditions of the hatches prior to de-mobilizing from the site. The investigation team will also conduct the following as part of their closeout documentation procedures:

1. The field team shall record either the highest or lowest data observed on the four-gas meter (whichever applicable) on the JHA document that is being used for that particular worksite. If an alarm occurred during the crawlspace entry, the alarm occurrence shall also be noted (see Crawlspace Entry Step 7). These values can be retrieved by using the peaks and lows function on the four gas meter by simply hitting the power button from the home or gas monitoring screen four times and recording the values.

2. After returning to the CDM Smith Libby project office, the field team shall scan a completed copy of the JHA document and save it to the folder on the Libby server titled "GPI JHA 2013" (or current year). This folder is located in the Design folder. The file naming convention will be:

    Address_date_JHA (example: 1011 Minnesota Ave_01-08-13_JHA)

3. The four-gas meter shall be shut off and placed back in the case for later use. Before storing, field team members shall take note of the battery symbol in the bottom left-hand corner of the display screen. If the meter needs charging, staff shall place the unit on charge so that it is ready for the next use.

6.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this procedure will be attained through a variety of processes, including, but not limited to, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this procedure.

6.1 Training

Every effort will be made to ensure consistency among staff entering crawlspaces in support of Libby investigation activities. Consistency will be achieved to the extent possible through proper training, use of designated field staff, and FTL oversight. Any deficiencies or inconsistencies in implementing this procedure noted by the FTL will require re-training of the field team.

6.2 Equipment Maintenance

The four-gas meter manufacturer's instructions regarding operating procedures and equipment maintenance will be reviewed by all field staff involved with crawlspace entry prior to equipment use. In addition, calibration of all four-gas meters used by CDM Smith staff will be performed by the FTL (or designee) at the beginning of each month. All four-gas meters will be calibrated according to the manufacturer's recommendations, and all calibration documentation maintained by the FTL.

Following the completion of the calibration process, the FTL shall notify (via email) a designated member of the H&S team so that the calibration information can be documented in Predictive Solutions™. The email shall include the serial number from the unit(s) that were calibrated and the date and time of the calibration(s).

Attachment 1

Figure 1 – Filling the tedlar bag with calibration gas

Attachment 2

Figure 2 – Applying calibration gas for bump testing

Attachment 3

Figure 3 – Extendable sampling probe with tubing attached to four-gas meter

NOTE: This SOP has been prepared for use at the Libby Asbestos Superfund Site. The applicability of this SOP at other sites should be evaluated by the site team with regard to site-specific goals and objectives.

Date: December 6, 2007 SOP No. ISSI-LIBBY-01 (Rev. 10)

Title: SOIL SAMPLE PREPARATION

SYNOPSIS: A standardized method for preparation of soil samples for asbestos analysis at the Libby Asbestos Superfund Site is described.

Original Author: William Brattin Syracuse Research Corporation[1]

Received by QA Unit:

APPROVALS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8:	Mary Goldade	12/11/07
Syracuse Research Corp.	WJ Brattin	12/10/07

[1] This SOP was originally prepared by ISSI Consulting Group. ISSI is no longer in existence, and finalization of the SOP was performed by Syracuse Research Corporation (SRC).

<u>REVISION LOG</u>

Revision Number	Revision Date	Reason for Revision
1	1/7/00	Incorporation of sieving to the sample preparation.
2	7/12/00	Revision in sieve size, other minor edits.
3	5/7/02	Incorporate minor edits
4	8/1/02	Modify sieving procedure, add grinding step
5	3/6/03	Incorporate modifications to the procedure and documentation requirements
6	3/24/03	Incorporate modifications to the log-sheets to conform with electronic data storage requirements and add grinder blank requirements.
7	8/5/03	Incorporate modifications to drying and sample storage procedures
8	5/4/04	Incorporate modifications to drying batch size and recording of preparation information
9	5/14/07	Incorporate modifications so as to expand use to other Operable Units (removed references to OU4 / CSF, changed Index ID to Sample ID). Repair formatting. Remove reference to missing Figure 1. Add optional use of electronic logs. Oven temperature set to 90±10 degrees C. Lowered inventory batch size from ~120 to ~50 samples so that one inventory batch can fit in one tub. Designate drying batch as one batch per oven (~20 samples). Allow for optional use of disposable drying pans. Remove direction to NOT move grinding plates during decontamination (new BICO design allows plates to be separated for decontamination without adjusting gap). Ovens will be calibrated daily. *[Note: Revision 9 was an unsigned version that reflects changes made at the Troy Preparation Laboratory. Some of the changes in Revision 9 are retained in Revision 10, below].*
10	12/06/07	Incorporate modifications so as to expand use to other Operable Units. Designate drying batch as ~20 samples. Allow for optional use of disposable drying pans. Allow alternative methods for decontamination of plate grinder. Clarify and modify QC requirements. General editing for clarity.

1.0 PURPOSE

This Standard Operating Procedure (SOP) has been prepared by the United States Environmental Protection Agency (USEPA) Region 8 to standardize the methods used to prepare soil samples from the Libby Asbestos Superfund Site for the analysis of asbestos content. This procedure is intended for use by employees of USEPA Region 8 and by contractors and subcontractors supporting USEPA Region 8 projects and tasks for the Remedial Investigation work performed at the Libby site. Deviations from the procedures outlined in this document must be reviewed and approved by the USEPA Region 8 Remedial Project Manager or Regional Chemist.

2.0 RESPONSIBILITIES

Each laboratory that performs soil preparation activities under this SOP must have a designated Preparation Laboratory Project Leader (PL^2). The PL^2 may be an USEPA employee or contractor. The PL^2 is responsible for ensuring that all personnel in the laboratory who perform work under this SOP are familiar with the SOP, and for ensuring that all work performed satisfies the requirements of this SOP and any other relevant laboratory-specific operating procedures. It is also the responsibility of the PL^2 to communicate and document the need for any deviations from the SOP with the appropriate USEPA Region 8 Remedial Project Manager or Regional Chemist.

All laboratory personnel preparing Libby soil samples are responsible for reading and understanding the requirement of this SOP, and for performing all applicable tasks in accordance with this SOP. Any laboratory worker who identifies any issues or encounters any difficulties in implementation of this SOP is responsible for promptly communicating the issue or difficulty to the PL^2. In addition, all laboratory personnel are responsible for reading and understanding the Health and Safety Plan (HASP) applicable to the soil preparation activities in that laboratory, and performing all tasks in accord with the requirements of that HASP.

3.0 EQUIPMENT

- General purpose laboratory oven - capable of maintaining a constant temperature of approximately 90°C.
- Analytical balance - capable of measuring in a range of 0.1 g to at least 2000 g, calibrated and accurate to the tolerance limits indicated in Attachment 2.
- Riffle splitter - with 3/4 inch chutes to split samples.

- Plate grinder - capable of accepting soil particles of approximately 1/4 inch diameter and grinding to produce particles of approximately 250 µm.

- HEPA Vacuum - A portable vacuum unit equipped with a high efficiency particulate air (HEPA) filter to remove any asbestos fibers and other soil particles from the exhaust air. Used to decontaminate equipment and maintain general laboratory cleanliness.

- Metal scoop or spoon - for transferring samples. Plastic scoops or spoons are not acceptable.

- 1/4 inch metal sieve and catch pan - for coarse sieving samples. Plastic sieves and pans are not acceptable.

- 60 mesh (250 µm) and 200 mesh (74 µm) metal sieves - for verification of the plate grinder settings. Plastic sieves are not acceptable.

- Clean quartz sand - required for preparation of grinding and drying blank samples and for decontamination of grinder.

- Clean soil - required for calibration of grinder.

- Drying pans with lids - used during the sample drying process, lids used to cover samples during transfer

- Sample containers - plastic ziplock bags (pint and gallon size).

- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex. Disposable, powderless.

- Personal Protective Equipment - as specified in the applicable Health and Safety Plan for the soil preparation laboratory.

- Laboratory notebook and pen - used to record progress, any problems or observations and deviations. All information in the laboratory notebook must be recorded in pen (not pencil).

- Sample Drying Log Sheets - (Attachment 1). Used to record all sample drying information.

- Sample Preparation Log Sheets - (Attachment 1). Used to record all sample preparation information (splitting, sieving and grinding).

- Equipment Calibration and Maintenance Logs for:

  - Analytical Balance (Attachment 2)
  - Plate Grinder (Attachment 3)
  - Ventilation Hood (Attachment 4)
  - HEPA Vacuum (Attachment 5)
  - Drying Oven (Attachment 6)

  These logs are used to record all maintenance and calibration records for the listed equipment. If hard copy, all entries must be recorded in pen, and the logs must be organized and maintained in a laboratory notebook.

- Sample Labels – Self-adhesive labels for attachment to sample bags.

- Trash Bags - used to dispose of gloves, wipes and other investigation derived waste.

- Indelible Marking Pen - used to record sample information onto plastic ziplock bags and to record logbook information.

4.0 METHOD SUMMARY

Figure 1 provides an overview of the steps in the soil preparation process. Soil samples received from the field are first dried in a laboratory oven and are then split into a preparation sample and an archive sample. The preparation sample is sieved to separate coarse material (> 1/4 inch) from fine material (< 1/4 inch). The fine material is ground to a particle size of less than 250 µm, and this fine ground material is split into several aliquots. This grinding step is needed to achieve a reasonable degree of homogeneity in the sample, and to allow for preparation of slides for microscopic analysis. The coarse fraction (if any) and one aliquot of the fine ground material are then sent to an analytical laboratory for asbestos analysis by methods specified in the project-specific Sampling and Analysis Plan. At present, the fine-ground sample is generally analyzed by Phase Contrast Microscopy (Visual Area Estimation) (PLM-VE) in accord with the most recent version of SOP SRC-LIBBY-03, and the coarse material is examined by stereomicroscopy and any observable particles of asbestos are removed and weighted in accord with the most recent version of SOP SRC-LIBBY-01.

It should be noted that this preparation method, coupled with these analytical techniques, is intended to estimate the total mass fraction of asbestos that is present in a sample, without regard to the current size distribution of the asbestos particles. That is, no distinction is drawn between asbestos that is presently in a large "lump" that is non-respirable and free asbestos fibers that are readily released to air and inhaled. Because of this, concentration values based on this approach may tend to overestimate the amount of currently releasable fibers, but do provide an estimate of the total amount of fibers that may be releasable in the future.

5.0 SOIL STORAGE

Upon receipt at the soil preparation facility, samples will be grouped into an inventory batch of 50-120 samples. Samples will be archived according to the inventory batch they are assigned to and filed by the Inventory Batch ID (box number) noted in the Sample Drying Log and Sample Preparation Log (Attachment 1).

6.0 BULK SOIL DRYING

6.1 Equipment Calibration

Samples will be weighed prior to and following drying activities. The analytical balance used for drying activities will be calibrated on days when samples are loaded into, or unloaded from, the oven. Before weighing samples, calibrate the balance using S-1 class weights and record all measurements, any required maintenance, and the balance number in the Analytical Balance Calibration and Maintenance Log (Attachment 2).

All drying activities will be performed under a negative pressure HEPA filtered hood or similar containment box. Prior to loading the oven, the ventilation hood will be calibrated to ensure that the ventilation system is operating properly. Ventilation hood calibration and any required maintenance will be documented in the Ventilation Hood Calibration and Maintenance Log (Attachment 4).

A HEPA vacuum will be used to decontaminate the oven following the removal of dried samples. Vacuum calibration will be performed daily, prior to drying activities. All system checks, required maintenance and the vacuum number will be recorded in the Vacuum Maintenance Log (Attachment 5).

Oven temperature calibration will be performed on a daily basis (during periods of operation). Oven temperature calibration and any required maintenance will be documented in the Oven Temperature Calibration and Maintenance Log (Attachment 6).

6.2 Drying Procedure

- Prior to unsealing and drying each sample, record on the Sample Drying Log the starting sample mass to the nearest 0.1 g. Include the technicians initials and the date.

- Group samples into drying batches of approximately 20 samples per batch. Assign each batch a drying batch number, and record this number on the Sample Drying Log, along with the SOP and Revision Number and the oven number used to dry the samples.

- Include one preparation blank in each drying batch. See Section 12.1 for more details regarding preparation blanks.

- Set the oven temperature to approximately 90±1°C. For every drying batch, check the oven temperature to verify that proper temperature[2] has been reached and document the start date/time and temperature in the Sample Drying Log.

- Transfer each sample to be dried from its ziplock storage bag into a clean drying pan. Each sample should be transferred to its respective drying pan under the negative pressure HEPA filtered hood. Label each drying pan with the Index ID[3] of the sample. Place each sample in the oven.

- Leave the samples in the oven for approximately 24-48 hours or until completely dry. Verify that each sample is dry by squeezing a portion of the soil with a freshly gloved thumb and forefinger to test the cohesiveness. Once it is confirmed that samples are dry, record the technician's initials, and the date and time of completion, in the Sample Drying Log.

- Turn off the oven and allow the samples to cool in the oven. Once the samples are cooled, unload each sample and transfer each sample volume to a clean ziplock bag, re-bag the sample with another clean ziplock bag and identify the dried sample with the Index ID. All samples should be transferred to ziplock bags under the negative pressure HEPA filtered hood to prevent potential exposure to fibers that might be released from the sample.

- Record the sample mass of each dried and bagged sample to the nearest 0.1 g along with the technician's initials and the date in the Sample Drying Log.

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[2] Drying temperatures in the range of 80-100°C will not compromise sample integrity, but monitoring of oven temperature to ± 1°C is needed to allow early detection of any problems with the oven temperature control.

[3] Unique sample identifiers at the Libby site are referred to as "Index ID" numbers rather than "Sample ID" numbers. However, the meaning is the same.

6.3 Decontamination

Decontaminate the inside of the hood and the inside of the drying oven by HEPA vacuuming and wet wiping all surfaces before loading a new batch for drying.

If drying pans are to be re-used, decontaminate all sample drying pans under the ventilation hood using compressed air and a HEPA vacuum to remove any residual organic material left on the pans. Wet wipe or brush off any visible material that is not removed using the vacuum.

7.0 DIVISION OF ARCHIVE AND PREPARATION SAMPLES

All dried samples are mixed and split into two portions: one portion is held in archive, and the second portion is prepared for asbestos analysis. The sections below describe the sample splitting procedure.

7.1 Equipment Calibration

Prior to any splitting, sieving, or grinding activities, calibrate the ventilation hood to ensure that the ventilation system is operating properly. Document ventilation hood calibration and any required maintenance in the Ventilation Hood Calibration and Maintenance Log.

7.2 Procedure for Sample Splitting

Splitting must be performed in the hood to prevent potential exposure to fibers that might be released from the sample. Samples will be divided using the following steps:

- Place the cooled, re-bagged samples in the hood, and knead the contents of the bag to break up any soil clumps.

- Place one collection pan on each side of the riffle splitter. Pour the sample from its plastic bag through the splitter in order to divide the sample into two equal sub-parts.

- After splitting, set aside one portion for sample preparation, as described below. If the mass of the portion for preparation is larger than about 200 grams, split the preparation sample again so that 3/4 of the original sample will be archived and 1/4 will be set aside for processing.

- Place the remaining portion(s) into a clean, ziplock bag, re-bag the sample in another clean ziplock bag, and store as an archive sample in the event additional analyses are required in the future. Identify the archive sample with the Index ID and the suffix "A" (for archive fraction). Record the technician's initials and date in the Sample Preparation

Log. Store the archive portion in the numbered inventory box noted in the Sample Preparation Log.

7.3 Preparation Duplicate Samples

One preparation duplicate sample will be prepared for every 20 field samples processed. A preparation duplicate is generated by using the riffle splitter to divide the preparation fraction into two equivalent portions ("parent" and "duplicate"). The duplicate portion is assigned an independent Index ID and both the parent sample and the duplicate sample are then processed in an identical fashion and are each submitted to the laboratory blind. For further information on preparation and processing of preparation duplicates, refer to Section 12.4.

7.4 Performance Evaluation Samples

Performance Evaluation (PE) samples are used to assess the accuracy of the analytical laboratory and to check for any potential contamination or loss of asbestos during processing. For further information on preparation and processing of PE samples, refer to Section 12.3.

7.5 Decontamination

The splitter need not be decontaminated following this step if the next use of the splitter will be the division of the fine ground fraction of the same samples into four fractions (see Section 10, below). If for any reason the next use of the splitter is division of material from a different sample, the riffle splitter must be decontaminated as follows.

- Use a HEPA vacuum and compressed air to decontaminate the splitter and brush or wipe off any visible material that is not removed by the air blast. The splitter is now ready to process the next sample.

8.0 SIEVING THE PREPARATION SAMPLE

All preparation samples are sieved prior to grinding to separate out the coarse and fine fractions. The sample sieving procedure is described in the sections below.

8.1 Equipment Calibration

All sieving activities will take place in the hood. Refer to Section 6.1 for details regarding the frequency of ventilation hood calibration.

Samples are weighed during sieving activities. The analytical balance will be calibrated daily with S-1 class weights before processing begins. All measurements, any required maintenance, and the analytical balance number will be recorded in the Analytical Balance Calibration and Maintenance Log.

8.2 Sample Sieving Procedure

Samples will be sieved using the procedure outlined below.

- Pour the sample onto a clean 1/4 inch stainless-steel sieve with a clean pre-weighed catch pan. Shake the screen until all particles <1/4 inch in size have passed through the screen into the pan. When needed, a pestle may be used to gently break up any remaining soil clumps to ensure all particles <1/4 in size pass through the screen.

- Pour all material which does not pass through the screen (>1/4 inch) into a new, tared, sample bag. This is the Coarse Fraction.

- Weigh and record the mass of the coarse fraction to the nearest 0.1 g in the Sample Preparation Log and record the technician's initials and the date. If all of the material passes through the screen, such that there is no coarse fraction, record a mass of zero for the coarse fraction in the Sample Preparation Log.

- Double-bag the coarse sample portion and identify the sample with the Index ID and "C" suffix on the sample bag. Coarse fraction samples are now ready to be packaged for shipment to the analytical laboratory or archived as directed.

- All material that passes through the 1/4 inch screen is the Fine Fraction. Weigh and record the mass of the fine fraction to the nearest 0.1 g in the Sample Preparation Log.

Whenever possible, immediately process the fine fraction material in accord with the approach described in Section 9.3 (below). If processing cannot occur immediately, pour the fine fraction material into a new ziplock bag and identify the fine sample material with the Index ID and the suffix "F" (for "fine fraction"). Double-bag the sample and identify the sample with the Index ID and suffix on the outside of the bag.

8.3 Decontamination

All non-disposable pans and sieves will be decontaminated between samples. Decontaminate sieves and pans (and the pestle, if used) under the ventilation hood using compressed air. Wipe or brush off any visible material that is not removed from the air blast. A HEPA vacuum may also be used to remove any residual material.

9.0 GRINDING THE FINE FRACTION

The fine fraction of each preparation sample will be ground to produce a material of about 250 µm[4]. The procedure for grinding the fine fraction is outlined below.

9.1 Equipment Calibration

All grinding activities will take place in the hood. Refer to Section 7.1 for details regarding the frequency of ventilation hood calibration.

A HEPA vacuum will be used to decontaminate the hood and processing equipment, following the preparation of each sample. Vacuum calibration will be performed daily, prior to grinding activities. All system checks, required maintenance and the vacuum number will be recorded in the Vacuum Maintenance.

A plate grinder will be used to process samples. The grinder will be calibrated daily or after any adjustments are made to the plates. To verify proper particle size (approximately 250 µm), and demonstrate that samples will not be over-processed, grind a sample of clean soil (rather than quartz sand) and sieve using stacked sieves. Clean soil will be provided by the United States Geological Survey (USGS). Unlike the coarseness of quartz sand, clean soil will more accurately approximate the typical grain size and texture of the Libby samples being processed and will reduce the chance of over-processing.

The grinder is adjusted acceptably if, after grinding of the clean soil sample, all material passes through a 60-mesh (250 µm) screen and is substantially retained by a 200-mesh (74 µm) sieve. If a significant amount of the ground clean soil sample is retained on the 60-mesh screen, or if a substantial fraction of the material passes through the 200-mesh screen, adjust the plates of the grinder until these targets are achieved. If the required particle size cannot be achieved even after plate adjustment, other grinder maintenance such as plate replacement may be required. Regardless, grinding of field samples cannot resume until the desired particle size is achieved. Document the grinder number, verification of acceptable adjustment and any observations in the Grinder Calibration and Maintenance Log.

Samples will be weighed following grinding activities. The analytical balance will be calibrated daily with S-1 class weights before processing begins. All measurements, any required maintenance, and the analytical balance number will be recorded in the Analytical Balance Calibration and Maintenance Log.

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[4] Note that the particle size is cited as "approximately 250 µm". This is due to the nature of grinding asbestos material. Some material that is longer than 250 µm may pass through the grinder if its longest side is parallel with the vertical grinder plates. The material that comes in contact more nearly perpendicular to the vertical grinder plates will be ground to <250 µm

9.2 Grinding Blanks

One grinding blank per grinder will be prepared daily, and will be associated with all samples prepared by that grinder on that day. For further information on grinding blanks refer to Section 12.2.

9.3 Grinding of Fine Field Samples

The sample portion that was sieved to < 1/4 inch will be ground to a particle size of approximately 250 µm. Set up a catch pan under the grinder to collect all the ground material. Take the fine sample set aside in Section 8.2, load the grinder hopper, and allow the fine sample to pass through the plate grinder into the catch pan. Note the technician's initials, date of grinding, and grinder number in the Sample Preparation Log.

The net recovery of fine ground material must not be less than 90% of the mass of fine material placed into the grinder. If recovery is less than 90%, soil grinding must be stopped and the grinder re-adjusted until the mass recovery of test sand and/or soil samples exceeds 90%.

9.4 Decontamination

Plate Grinder

The details of decontamination of the plate grinder and it associated containers and equipment may vary depending on the model of grinder that is being used.

If the plate grinder can be readily disassembled for cleaning without altering its grinding properties, disassemble the grinder and clean the chutes and plates with the HEPA vacuum and compressed air. Then, if needed, use wet wipes to ensure decontamination. If wet wipes are used, the plates and chutes must be thoroughly dried before reassembly. If the grinder is not easily disassembled, clean the grinder with the HEPA vacuum and several blasts of compressed air, paying special attention to areas where dust from the grinding process is known to accumulate (e.g., between the plates and areas adjacent to the catch pan clamps). Then, pass an aliquot of approximately 20 g of quartz sand through the grinder to clean out any residual soil. Discard the quartz sand and re-clean the grinder with the vacuum and another round of high pressure air blasts. After this decontamination procedure, the grinder is ready to process the next sample.

In general, all soil containers, hoppers and catch pans associated with use of the grinder should be decontaminated by using a HEPA vacuum and/or wet wipes, followed by a blast of high pressure air.

Calibration Sieves

The stacked sieves used to calibrate the plate grinder will be decontaminated using a HEPA vacuum and compressed air between calibration uses.

10.0 SPLITTING OF THE FINE GROUND SAMPLE

The fine ground soil sample should be distributed into four approximately equal subsamples using a splitter. All splitting activities will be performed in the hood. Refer to Section 7.1 for details regarding the frequency of ventilation hood calibration.

10.1 Splitting Procedure for Fine Ground Sample

The following method for splitting a soil sample was adapted from EPA 540-R-97-028 (USEPA, 1997):

- Set up one receiving pan on each side of the splitter. Load the soil from the grinder catch pan (Section 9.3) into the splitter, collecting the sample in two receiving pans.

- Tap the catch pan vigorously several times to free any remaining material. Tap the splitter to facilitate the flow of all material through the chutes into the receiving pans.

- Empty one receiving pan into the grinder catch pan and the other receiving pan into the sieve catch pan. Set the sieve catch pan aside; this portion of fine ground sample will be split again later.

- Replace the receiving pans under the splitter. Take the grinder catch pan, containing half of the fine ground sample, and re-load the contents into the splitter as detailed above. Repeat the process of dispersing the sample material by shaking the catch pan and tapping the splitter to uniformly distribute the sample. The resulting splits are the "FG1" and "FG2" portions in the Sample Preparation Log.

- Take these two portions and carefully transfer each into a clean, tared, ziplock sample bag. Re-bag one sample portion in another clean ziplock sample bag and identify this fine ground sample with the Index ID, the suffix "FG" (for "fine fraction, ground") and the fraction number 1, (ex. CS-12345-FG1 for fine ground fraction #1). Identify the bagged second portion with the Index ID, the suffix "FG" and the fraction number 2 and set aside to be re-bagged with the following fine ground portions:

- Place the two empty receiving pans from the "FG1" and "FG2" portion next to the splitter. Repeat the splitting procedure using the other fine ground portion set aside in the sieve pan and split the remaining sample material to create the "FG3" and "FG4" portions.

- Take the remaining "FG3" and "FG4" portions and carefully transfer each into a clean, tared, ziplock sample bag, identify each remaining fine ground sample with the Index ID as noted above.

- Weigh each sample portion (FG1 through FG4), and record each mass along with the technician's initials and date in the Sample Preparation Log.

Combine all of the bagged coarse and fine portions of the sample into one large clean, ziplock sample bag.

Coarse and fine ground samples are now ready to be packaged for shipment to the analytical laboratory or archived as directed. When samples are requested for shipment, the "FG1" fraction will be sent first. If further analyses are required for the fine ground portion, the subsequent fractions will be double bagged and sent (i.e., FG-2 then FG-3, etc.). All archived fine ground portions will be filed in the appropriate inventory archive box noted in the Sample Preparation Log.

10.2 Decontamination

The splitter must be decontaminated between each sample. Use the vacuum and/or wet wipes followed by a blast of compressed air to decontaminate the splitter and brush or wipe off any visible material that is not removed by the vacuum or air blast. The splitter is now ready to process the next sample.

11.0 DOCUMENTATION

Index ID numbers are recorded in the Sample Drying Log, Sample Preparation Log and on all sample containers. Sample Drying Logs and Sample Preparation Logs will be filed or archived according to their associated dry batch and preparation batch number. If revisions to the Sample Drying Log and/or Sample Preparation Log are necessary, the appropriate parties will be notified of the changes, however, these changes will not necessitate revision to the current standard operating procedure, a modification form will be filled out to document the revisions.

As mentioned above, the following equipment calibration and maintenance logs will also be maintained:

- Daily analytical balance calibration using S-1 class weights (Attachment 2)
- Daily grinder setting verification for calibration check and/or post-adjustment verification, grinder maintenance as necessary (Attachment 3)
- Daily ventilation hood operating condition verification (i.e., inline filter checks, changes) (Attachment 4)
- HEPA vacuum maintenance and bag changes (Attachment 5)
- Weekly oven temperature calibration, oven maintenance as necessary (Attachment 6)

In addition, a laboratory notebook will be maintained by each individual or team that is preparing samples. For each day that samples are processed, the following information should be collected:

- Date
- Time
- Personnel
- Personal protective equipment (PPE)
- SOP (including revision number) and any other laboratory-specific governing plan being followed
- Descriptions of any deviations to the SOP, the reason for the deviation and/or any modification forms being followed
- Summary of laboratory activities (including number of samples prepared, and equipment calibrated and used)

12.0 QUALITY CONTROL

Quality control (QC) samples are inserted into the sample train to monitor for potential contamination introduced during the preparation process or to assess accuracy of analysis that may be affected due to preparation procedures. If samples results indicate the occurrence of contamination or inconsistent results, the PL^2 will be notified. The PL^2 will then notify the EPA Regional Project Manager and the Regional Chemist in order to review laboratory procedures and identify any changes in preparation laboratory methods and procedures that may be necessary. Any such reviews and resultant changes will be documented accordingly by the PL^2.

12.1 Preparation Blanks

A preparation blank is a sample of 200-400 grams of clean quartz sand that is treated identically to a field soil sample. That is, the preparation sample is dried in the oven along with the field soil samples, split into archive and preparation fractions using a riffle splitter, screened through a ¼ inch screen (even though there are no particles larger than ¼ inch), and ground by passing through the plate grinder. This type of sample is intended to detect contamination that may occur at any stage of the soil preparation procedure.

At least one preparation blank will be processed with each drying batch of approximately 20 field samples. Preparation blanks will be assigned a random and unique Index ID and will be submitted to the laboratory blind. The Index ID assigned to each preparation blank must be in accord with the numbering system specified in the program-specific project plan.

Detection of asbestos fibers (any type) in any preparation blanks at a level greater than Non-detect (Bin A) by PLM-VE should be taken as a sign of potential cross-contamination, and all field samples associated with the preparation batch for the preparation blank having detectable asbestos (> Bin A) will be reviewed and qualified appropriately if detectable levels of asbestos are also found in any of the corresponding field samples. If the overall fraction of preparation blanks that contains detectable asbestos (> Bin A) exceeds 1%, a review of laboratory procedures should be undertaken to identify and address the source of the contamination.

12.2 Grinding Blanks

A grinding blank consists of 100-200 grams of clean quartz sand that is passed through the plate grinder. The purpose of this type of sample is to evaluate the effectiveness of decontamination procedures for the plate grinder.

One grinding blank per grinder will be prepared for each day that field samples are being ground. Each grinder used in the laboratory will be assigned a number and all samples processed will be associated with the grinder used for preparation. The grinder number used for each sample will be noted in the Sample Preparation Log. Grinding blanks will not be dried, split for archive, or sieved. Rather, a grinding blank will only be ground and split into four fine ground samples. The grinding blank is assigned a random and unique Index ID and is submitted to the laboratory blind. The Index ID assigned to each grinding blank must be in accord with the numbering system specified in the program-specific project plan.

Detection of asbestos fibers (any type) in any grinding blank at a level greater than Non-detect (Bin A) should be taken as a sign of potential cross-contamination, and all field samples associated with the grinding blank that reports detectable asbestos (> Bin A) will be reviewed and qualified appropriately if detectable levels of asbestos are also found in any pf the corresponding field samples. If the overall fraction of grinding blanks that contains detectable asbestos (> Bin A) in a soil preparation facility exceeds 1%, steps should be taken to develop an improved method for grinder decontamination.

12.3 Performance Evaluation Samples

Performance Evaluation (PE) samples are samples of Libby soil that have been spiked with a known amount of Libby Amphibole (LA) asbestos. These samples were prepared by the USGS for use at the Libby site by spiking uncontaminated soil from Libby with a known mass of LA fibers collected at the mine site, and then grinding the sample to a particle size of ≤ 250 um as described above. Several different concentration values of PE samples were prepared, ranging from < 0.1% to 2%. Each bottle contains about 100 grams of the PE material.

PE samples will be utilized in two ways.

> First, the soil preparation facility will insert untreated PE samples into the analytical sample train sent to the laboratory for PLM-VE analysis. This type of PE sample is intended to evaluate the performance of the analytical laboratory (rather than the preparation facility).
>
> Second, the soil preparation laboratory will process PE samples in the same way that field soil samples are processed, as detailed below. This type of PE sample is intended to determine if there is any loss of asbestos during sample processing. In addition, considered in conjunction with a grinding blank that is passed through the decontaminated grinder immediately following the PE sample, the PE sample will also be used to facilitate assessment of grinder decontamination procedures.

The frequency of each type of PE sample (unprocessed and processed) should be one per month for each month in which soil processing is occurring. These should be distributed approximately evenly between the different concentration values that are available for PE samples.

Each month that soil processing is occurring, the procedure to be followed for generation and submittal of PE samples is as follows:

1. Select a PE bottle for inclusion.
2. Thorough mix the contents of the PE bottle by inversion (a minimum of 10 times) and/or rolling (a minimum of 10 minutes).
3. Remove an aliquot of about 20 grams and package this for submission to the analytical laboratory without any processing. If more than one laboratory is analyzing samples, rotate the submittal of unprocessed samples so that all laboratories receive approximately equal total number of unprocessed PE samples.
4. Take the remainder of the PE bottle (about 80 grams) and carry this material through the full sequence of steps applied to each field sample, starting with oven drying. After splitting the dried sample with the riffle splitter, recombine the samples so that the full 80 grams is screened through the ¼ inch sieve and passed through the plate grinder. Thus, there is no archive split for PE samples. After grinding and splitting, this should result in four sub-samples of processed PE sample. Prepare three of these for submittal to the analytical laboratories, and hold one sample in archive.

Results of PE samples processed by the soil preparation laboratory are evaluated by comparing the reported results for LA to the nominal results. Deviations from nominal may be the result of variations either in soil processing procedures and/or in the analytical procedure. If the frequency of strongly discordant results (i.e., the results of the PE sample differ by more than one bin from the nominal result) exceeds 10%, then the source of the inconstancy should be investigated and remedied.

12.4 Preparation Duplicates

A preparation duplicate is prepared by using a riffle splitter to divide a field soil sample into two approximately equal portions, creating a parent and duplicate sample. Both samples are then processed in the same fashion. The preparation duplicate is assigned a unique Index ID, and is submitted to the laboratory blind. The Index ID assigned to each preparation duplicate must be in accord with the numbering system specified in the program-specific project plan.

One preparation duplicate sample will be processed for every 20 field samples prepared (5%). Results from duplicate samples serve to evaluate the precision of the combined sample preparation process and the laboratory analysis. Inconsistent results between parent and duplicate may be due either to variability in sample preparation, sample analysis, and/or to small scale variability in the sample that is not fully controlled by mixing and splitting. If the overall frequency of strongly discordant results (i.e., the results for the parent sample and duplicate are different by more than one bin) is greater than 10%, steps should be taken to identify and address the source of the variability in the sample preparation procedure.

13.0 DECONTAMINATION

All non-disposable equipment used during soil sample preparation must be decontaminated prior to use. Scoops, spoons, splitters, sieves and drying pans that are re-used must be decontaminated with a HEPA vacuum, compressed air, wet-wiping and/or by brushing off any residual material. If soil particles are visible on any of the equipment, repeat the decontamination procedure until the equipment is clean. To reduce the potential for human exposure in the laboratory, COMPRESSED AIR SHOULD BE USED CAREFULLY AND ONLY UNDER VENTED HOODS.

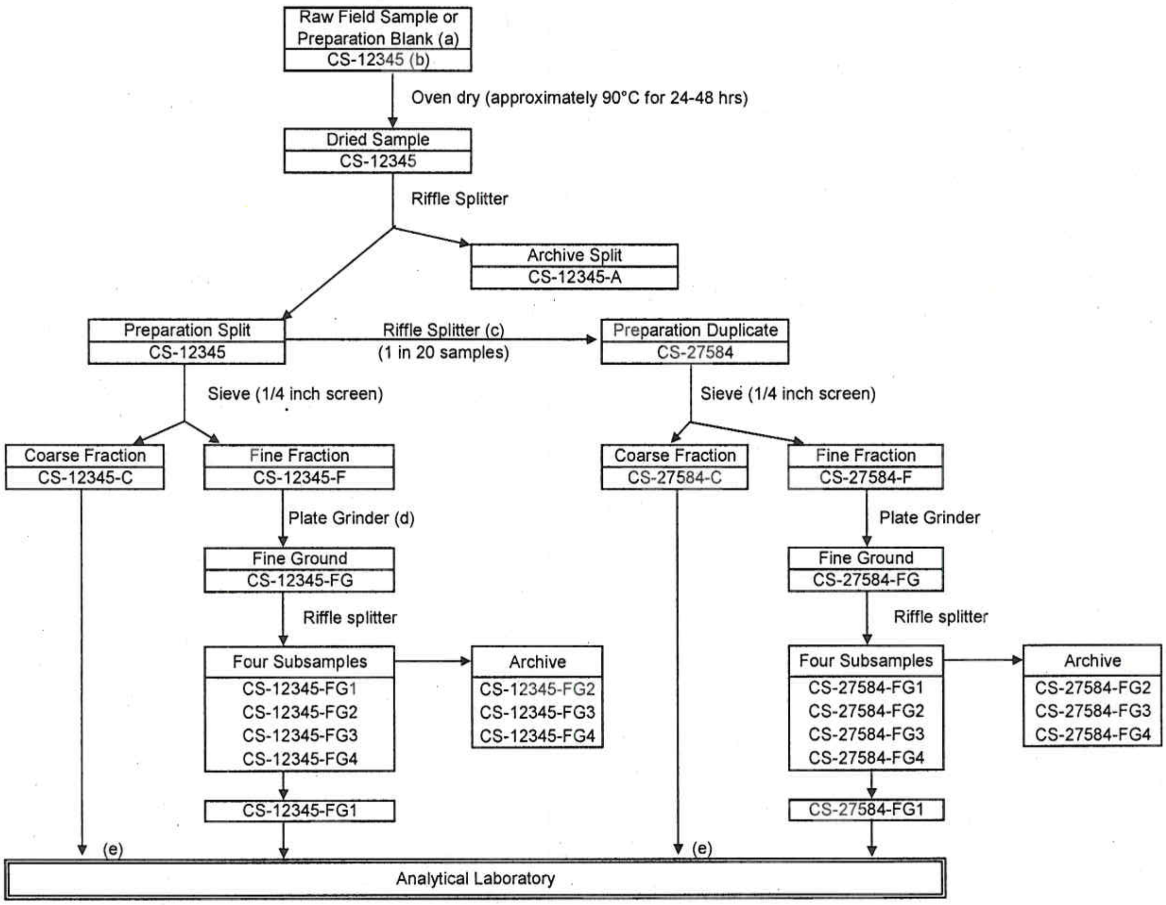
Detailed decontamination procedures for specific equipment are noted in Sections 6.3, 7.5, 8.3, 9.4, and 10.2.

14.0 REFERENCES

American Society for Testing and Materials. 1998. Standard Practice for Reducing Samples of Aggregate to Testing Size, ASTM Designation: C 702 - 98, 4 p.

USEPA. 1997. Superfund Method for the Determination of Releasable Asbestos in Soils and Bulk Materials. EPA 540-R-97-028.

FIGURE 1 SOIL PREPARATION FLOW DIAGRAM



NOTES:

(a) A preparation blank (200-400 grams of clean silica sand) is prepared in the same way as field samples at a rate of 5%

(b) Example Index ID (sample number) shown to illustrate naming conventions

(c) A preparation duplicate is prepared at a rate of 5%

(d) A grinding blank (100-200 grams of clean sand) is passed through the plate grinder and split into 4 sub-samples at a rate of 5%

(e) Coarse sample will be returned to EPA for archive after laboratory analysis

ATTACHMENT 1

SAMPLE DRYING AND SAMPLE PREPARATION LOG SHEETS

Sample Drying Log Sheet

Laboratory Name: ______________________ Sheet No.: ______________

Drying Begun: date ______________ time ______________

Drying Complete: date ______________ time ______________

Oven number: ______________

Oven temp: ______________°C

	Index ID	Inventory ID No.	SOP and Rev No.	Sample mass (g) Before drying	After Drying	Initials and date	Original Sample ID and Notes (indicate if preparation blank)	QC Initials and Date
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

Sample Preparation Log Sheet

Laboratory Name: ______________________________ Sheet No.: _______________

Preparation Batch: ______________________________

	Index ID	SOP and Rev No.	Inventory ID	Drying Batch ID	Archive Sample Splitting	Duplicate Sample Splitting	Sieving			Sample Grinding		Sample Splitting					Original Sample Identification and Notes (indicate if grind blank, prep blank, or duplicate pair. For duplicate pair enter the parent ID)	QC
							Sample Mass (g)					Sample Mass (g)						
					Initials and date	Initials and date	Coarse Fraction > 1/4"	Fine Fraction < 1/4"	Initials and Date	Initials and Date	Grinder #	FG1	FG2	FG3	FG4	Initials and Date		Initials and Date
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

The following preparation steps require Technician Initials and Date to document activity: Sample Drying, Archive Sample Splitting, Preparation Duplicate Splitting, Sieving, Homogenization, Sample Splitting

ATTACHMENT 2

ANALYTICAL BALANCE CALIBRATION AND MAINTAINANCE LOG SHEET

Preparation Laboratory = ______________________________

Balance # = ________________

Measurement Number		S - 1 Class Weight Measurements				Measurement within range? Yes or No	If "No" Recalibrate	Technician Initials	QC check initials
	Calibration Weights	0.1 g	1 g	10 g	100 g				
	Tolerance Limit Range	0.05 - 0.15 g	0.90 - 1.10 g	9.75 - 10.25 g	99.00 - 101.00 g				
	Date								
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

The analytical balance calibration will be verified daily.
All tolerance limits are standard tolerance limits for Class S-1 weights.
After 20 measurements, the tolerance range will be evaluated for reasonableness.
Weights falling outside the range require that the balance be recalibrated using all S-class weights

Sheet No.: Balance - ______________

ATTACHMENT 3

GRINDER CALIBRATION AND MAINTAINANCE LOG SHEET

Preparation Laboratory = ______________________________

Grinder # = _______________

Date	Activity Type (D, A, M)	Sieve Test		Notes (Include description of action/maintenance)	Technician Initials	QC Check Initials
		60 mesh acceptable Y or N	200 Mesh acceptable Y or N			

D = daily calibration
A = Adjustment Calibration Verification
M = Maintenance Only
For the 60 mesh sieve test to be acceptable all of the clean soil must pass through the sieve.
For the 200 mesh sieve test to be acceptable a substantial portion of the ground soil must be retained on the sieve.
Failure of either sieve test requires adjustment of the plates followed by adjustment verification prior to grinding samples.

Sheet No.: Grinder - _______________

ATTACHMENT 4

VENTILATION HOOD CALIBRATION AND MAINTAINANCE LOG SHEET

Preparation Laboratory = ______________________________

Ventilation Hood # = _________________

Date	In-line HEPA indicators acceptable?	Notes (Include description of action/maintenance)	Technician Initials	QC Check Initials

Ventilation system operating conditions should be verified daily
In-line system should indicate the velocity/negative flow is 100 ft/min. If not, the problems with the system must be corrected prior to processing samples. Note actions or maintenance taken.

Sheet No.: Hood - ______________

ATTACHMENT 5

HEPA VACUUM CALIBRATION AND MAINTAINANCE LOG SHEET

Preparation Laboratory = ______________________________

Vacuum # = _________________

Date	System Check Acceptable? Yes or No	HEPA filter clean? Yes or No	Bag fill level acceptable? Yes or No	Notes (Include description of action/maintenance performed)	Technician Initials	QC Check Initials

Physically check the vacuum suction and note audible change in motor daily. If significant reduction in the vacuum suction or motor "strain" is audibly noted then the system check is unacceptable. If unacceptable, perform and document the HEPA filter and bag maintenance checks above and perform maintenance.

Sheet No.: Vacuum - _______________

ATTACHMENT 6

OVEN CALIBRATION AND MAINTAINANCE LOG SHEET

Preparation Laboratory = ______________________________

Oven # = _________________

Date	Certified Temperature Reading (°C)	Thermometer ID	System Check Acceptable? (90+/-1 °C) Yes or No	Notes (Include description of action/maintenance performed)	Technician Initials	QC Check Initials

Sheet No.:Oven - ______________

Date: 1/23/07 SOP No. EPA-LIBBY-08

Title: <u>INDIRECT PREPARATION OF AIR AND DUST SAMPLES FOR TEM ANALYSIS</u>

Author: Ron Mahoney, Ed Cahill EMSL Analytical, Inc.

SYNOPSIS: A standardized method is presented for indirect preparation of air and dust samples for analysis by TEM.

Received by QA Unit:

APPROVALS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible]	1/23/07

REVISION LOG

Revision	Date	Reason
0	11/28/06	--
1	1/23/07	Clarification of filter configuration, secondary and tertiary dilution procedures.

1.0 PURPOSE

Some air samples collected at the Libby Superfund site are overloaded with debris and/or have obvious non-uniform loading, so analysis for asbestos by Transmission Electron Microscopy (TEM) requires an indirect preparation of the sample. All dust samples collected at the Libby Superfund site are prepared for TEM analysis using an indirect preparation. The purpose of this SOP is to provide a standardized procedure for the indirect preparation of air and dust samples that minimizes the loss of sensitivity. In addition, this SOP allows for the retention of a portion of the original air sample filter for archive whenever possible.

2.0 RESPONSIBILITIES

The Laboratory Director is responsible for ensuring that all laboratories participating in the analysis of air samples at the Libby site are aware of this SOP and that all analysts follow this SOP. Laboratory managers and analysts are responsible for communicating to the Libby laboratory coordinator (CDM), Volpe Center and appropriate USEPA Region 8 Remedial Project Manager or Regional Chemist any recommended changes or proposed improvements to the SOP.

3.0 EQUIPMENT

Equipment needed to perform indirect preparations of air samples includes the following:

- Transmission electron microscope (NVLAP compliant)
- Energy dispersive X-ray system (NVLAP compliant)
- High vacuum carbon evaporator with rotating stage
- HEPA hood (NVLAP compliant)
- Exhaust or fume hood
- Particle-free water
- Glass container for ashing
- Disposable single use containers of at least 100 ml capacity
- Waterproof marker
- Forceps
- Ultrasonic bath
- Appropriate disposable glass or variable pipets with disposable tips
- Disposable 25 mm filter funnels
- Side arm filter flask
- Cellulose support pad, 25 mm diameter
- MCE filters, 25 mm diameter, $\leq$ 0.22 µm and 5.0 µm pore size
- Storage container for 25 mm filter
- Glass slides, approximately 25 x 76 mm in size
- Scalpel blades, # 10 or equivalent and handle
- Desiccator or low temperature drying oven
- Acetone, reagent grade
- Glacial acetic acid

- Plasma asher, low temperature
- pH paper
- Tygon tubing, or equivalent
- Small vacuum pump for filtration
- Glass petri dishes
- Jaffe washer
- Carbon evaporator rods
- Wash bottles, plastic
- Reagent alcohol

4.0 METHOD SUMMARY

Figure 1 presents a simplified overview of the TEM indirect preparation procedure for overloaded air samples and dust samples. As seen, there are two general indirect preparation procedures, one that includes ashing of the primary filter and one that does not include ashing of the primary filter.

Laboratory modification LB-000053 provides a list of which sample prefix codes shall be prepared using an ashing procedure and which should not be prepared using an ashing procedure. In cases where there is a conflict regarding sample type between the sample prefix as defined by the most recent version of LB-000053 and the chain of custody instructions, the chain of custody instructions take precedent. Additionally, once sample preparations have begun, there may be cases where the analyst determines that ashing is necessary to obtain acceptable filter loading. Samples for which ashing may be warranted include indoor air or dust samples collected from properties with elevated levels of organic particulates (e.g., due to cigarette smoke or use of a wood-burning stove). In these samples, ashing may further reduce particulate loading, thus allowing for an improved analytical sensitivity.

The sections below present the detailed steps associated with each procedure. For all indirect preparations, specimen preparation should be performed in a clean facility that is separate from both bulk and air preparation areas and preparation shall take place in a negative flow HEPA hood to prevent any possible contamination of the laboratory or personnel.

4.1 PROCEDURE 1: Indirect Preparation with Ashing

This procedure should be followed for air and dust samples where LB-000053 or the chain of custody form indicates that ashing should be performed. For the purpose of the Libby Superfund Site, air samples are defined as overloaded if there is >25% obscuration on the majority of the grid openings.

If there is no loose material present in the air cassette or adhering to the cowl, this procedure is generally similar to the indirect preparation method specified in ISO 13794, but has been modified to increase the total solution volume from 40 ml to 100 ml and to retain a portion of the original filter. The use of a 100 ml final volume is selected because it allows for preparation of a series of indirect samples with volumes that are sufficiently large that secondary dilution is not needed to ensure uniform deposition on the filter.

If there is loose material present in the air cassette or adhering to the cowl, or if the sample is a dust sample, a portion of the original filter is not retained for archive, since it is assumed that there will be uneven loading on the filter. Because of this, an archived portion of the original filter is unlikely to be representative. In this case, the indirect preparation procedure is similar to the method specified in ASTM D-5755, but has been modified to include an ashing of the primary filter.

4.1.1 Carefully wet-wipe the exterior of the cassettes to remove any possible contamination prior to taking the cassettes into the clean preparation area.

4.1.2 Within a safety hood, carefully open the cassette and verify if there is any loose material in the cassette or adhering to the cowl. **If this is an air sample and there is no visible loose material present, proceed to Step 4.1.6.**

4.1.3 Any loose material that is present in the cassette should be poured into a disposable 50 ml glass beaker or similar container.

4.1.4 Using freshly cleaned forceps, remove the sample collection filter from the sampling cassette and place it in the same disposable 50 ml glass beaker or similar container with the side containing the sample facing down.

4.1.5 Using a 50/50 alcohol/particle-free water solution, rinse any material adhering to the cowl into a new 25 mm diameter disposable filtration funnels. If the filtration unit does not come pre-assembled with the necessary components (e.g. contains a glass fiber filter instead of the required MCE filter), it will be necessary to disassemble the stock cassette as it comes from Whatman and discard the glass-fiber filter. Rinse the filter unit thoroughly with particle free water and reassemble the filter unit using a cellulose support pad (Pall 66238), a 5.0µm pore size MCE diffuser filter (Enviropore FILA500A025A), and a 0.2 µm pore size MCE final filter (Enviropore FILA020A025A). Apply vacuum. When all solution has passed through, rinse sides of filter funnel with a stream of particle free water to dislodge any particulate that might be adhering to the sides of the filter funnel. Once filtration is complete turn off vacuum, remove filter from unit and dry. Once the filter is dry, place it in the container with the original filter and **proceed to Step 4.1.8**.

4.1.6 Using freshly cleaned forceps, remove the sample collection filter from the sampling cassette and place it on a clean glass microscope slide that will be used as a cutting surface. Using a freshly cleaned curved scalpel blade, cut off ½ of the filter (estimate the ½ as precisely as possible as this affects the final concentration) with a rocking motion.

4.1.7 Place the remaining portion of the original filter in archive. (Note: In cases where an initial direct preparation of an air sample was attempted and found to be overloaded, this archive portion will be approximately ¼ of the original filter.) Place ½ of the primary filter in a clean, single use disposable glass container with the side containing the sample facing down.

4.1.8 Cover the container with aluminum foil, forming a tight seal around the mouth.

4.1.9 Perforate the foil in 15-20 places with a syringe needle to allow for gas exchange during plasma ashing.

4.1.10 Place the sample container in the plasma asher chamber. Depending on the size of the plasma asher chamber, several samples may be ashed simultaneously.

4.1.11 Operate the plasma asher using the minimum power at which a glow-discharge is observed, until the filter appears to be completely ashed. Loss of particulate and fibers from the container will occur if the plasma asher is operated at excessive radio-frequency power. During ashing of mixed cellulose ester (MCE) filters, a critical point is reached during the oxidation at which a sudden, violent ignition may occur if the radio-frequency power is excessive. This may result in a loss of fibers from the container, contamination of the interior of the chamber, and possible cross-contamination of the samples. For this reason, ashing of the blank should be observed closely during the early stages of oxidation, in order to ensure that the radio-frequency power setting is such that sudden ignition does not occur.

4.1.12 After 100% ashing is complete based on visual observation, increase the plasma asher power to maximum and ash for a period of one additional hour.

4.1.13

While final ashing is in progress, set up the filtration system to be used. In order to minimize the chances of contamination, only 25 mm diameter disposable filtration funnels shall be used. If the filtration unit does not come pre-assembled with the necessary components (e.g. contains a glass fiber filter instead of the required MCE filter), it will be necessary to disassemble the stock cassette as it comes from Whatman and discard the glass-fiber filter. Rinse the filter unit thoroughly with particle free water and reassemble the filter unit using a cellulose support pad (Pall 66238), a 5.0µm pore size MCE diffuser filter (Enviropore FILA500A025A), and a 0.2 µm pore size MCE final filter (Enviropore FILA020A025A). Filter as usual, using restraint with the amount of vacuum applied to avoid uneven loading. Add 20 ml of particle-free water to the filtration apparatus prior to applying vacuum and introduction of the sample suspension. When seating the filters in the filtration unit, it is essential that the vacuum be evenly applied to help ensure an even distribution of particulate on the filter. There should be no air bubbles or surface abnormalities anywhere in the filter assemblage. This is accomplished through wetting each successive filter as it is placed in the filtration unit and applying a light vacuum. This will ensure that the filters are flat and that there are no air bubbles.

4.1.14 After ashing is complete, admit air slowly to the chamber and remove the samples from the plasma asher chamber and place back into a safety hood.

4.1.15 Remove the aluminum foil from the top of the sample container.

4.1.16 Using particle free water in a squirt bottle, carefully rinse the ashed residue from the ashing container into a clean disposable sample container of at least 100 ml with a watertight lid, such as a sealed specimen cup. Rinse the residue into the 100 ml container to an initial volume of approximately 90 ml. Adjust pH to approximately 3-4 using a 10% solution of glacial acetic acid, and checking with pH paper. Bring the final volume to 100 ml and cap tightly.

4.1.17 Briefly hand shake (3 seconds) the capped container containing the sample suspension.

4.1.18 Place the container in a calibrated tabletop ultrasonic bath and sonicate at 50 - 100 nW/ml for three minutes. The liquid level in the bath should be ½ to ¾ the height of the sample containers. Wipe the outside of the sample containers dry when removing them from the bath.

4.1.19 After sonication, lightly hand shake the suspension for 3 seconds, and allow it to stand undisturbed for 2 minutes to allow large particles to settle to the bottom or float to the top.

4.1.20 For each sample, prepare three secondary filters by applying volumes of 50 ml, 25 ml, and 10 ml. For air samples where the direct preparation proves to be overloaded, it is acceptable to filter aliquot volumes other than the usual 10 ml, 25 ml, and 50 ml series, either a greater or lesser volume, in order to produce a sample with the highest possible f-factor without violating the overload criteria. Draw each aliquot to be filtered with the same pipette and dispense into the appropriate filter funnel. Avoid pipetting any large settled or floating particles. Apply vacuum to the filtration apparatus to draw each volume through the filter. For samples where the 10 ml aliquot filter is obviously overloaded and a secondary dilution will be required (see 4.1.21), it is not necessary to attempt to filter the 25 ml and 50 ml aliquots through 25 mm filter units.

4.1.21 If a preliminary observation of the 10 ml secondary filter appears overloaded take 10 ml of the remaining volume and dilute to 100 ml. From this secondary dilution, prepare a second series of filters using 50 ml, 25 ml, and 10 ml (corresponding to 5 ml, 2.5 ml, and 1 ml of the original suspension). Based on the original 10 ml aliquot filter loading, it is acceptable to filter aliquot volumes other than the usual 10 ml, 25 ml, and 50 ml series in order to produce a sample with the highest possible f-factor without violating the overload criteria. In some instances, it may be necessary to perform a tertiary serial dilution, taking 10 ml of the secondary dilution, adding it to 90 ml of particle free water, and filtering another series of aliquots of 10 ml, 25 ml, and 50 ml.

4.1.22 Disassemble the filtration units. Carefully remove the filters from the filtration apparatus using fine forceps, being careful to only touch the inactive rim of the filter that has not been exposed to the sample. Place each filter in a labeled petri dish or other similar container, active side up and dry.

4.1.23 Select the secondary filter from the dilution series yielding the largest possible f-factor (highest possible volume) which does not violate the criteria for an overloaded sample. Experience has shown that a light staining of the filter will yield a suitable preparation for analysis.

4.1.24 Perform a standard TEM sample preparation procedure.

4.1.25 If TEM examination of the lowest volume aliquot filtered is deemed overloaded (>25% particulate), consult with the Libby laboratory coordinator (CDM) to select the most appropriate next step.

4.1.26 Carefully label and place each of the unused secondary filters and the remaining portion of the selected secondary filter in archive.

4.1.27 Place any remaining sample solution in a graduated cylinder or pipet. The largest known quantity of the remaining solution should be filtered through a 25 mm disposable filtration unit with a $\leq$ 0.22 µm/5.0 µm pore size MCE filter set in conjunction with a cellulose support pad and dried after removal from the filtration unit. A larger diameter (e.g. 47 mm) filtration unit with the same filter configuration may be used as needed to avoid situations where a 25 mm diameter filter may become obstructed with material. The dried filter shall be placed in an appropriate container, and labeled with the sample number, filter type, and volume applied to the filter. This filter will then be archived with the other archived filters from the sample.

4.1.28 Discard the remaining portion of the sample solution using standard laboratory protocols.

4.2 PROCEDURE 2: Indirect Preparation without Ashing

This procedure should be followed for air and dust samples where LB-000053 or the chain of custody form indicates that ashing should not be performed. For the purpose of the Libby Superfund Site, samples are defined as overloaded if there is >25% obscuration on the majority of the grid openings.

If there is no loose material present in the air cassette or adhering to the cowl, this procedure is generally similar to the indirect preparation method specified in ASTM D-5755, but has been modified to allow for an archive of the original filter.

If there is loose material present in the air cassette or adhering to the cowl, or if the sample is a dust sample, a portion of the original filter is not retained for archive, since it is assumed that there will be uneven loading on the filter. Because of this, an archived portion of the original filter is unlikely to be representative. In this case, the indirect preparation procedure is equivalent to the method specified in ASTM D-5755.

4.2.1 Carefully wet-wipe the exterior of the cassettes to remove any possible contamination prior to taking the cassettes into the clean preparation area.

4.2.2 Carefully open the cassette and verify if there is any loose material in the cassette or adhering to the cowl. **If this is an air sample and there is no visible loose material present, proceed to Step 4.2.5**.

4.2.3 Using a 50/50 alcohol/particle-free water solution, rinse any material adhering to the cowl down onto the sample collection filter (still inside the sampling cassette).

4.2.4 Using freshly cleaned forceps, remove the sample collection filter from the sampling cassette and place it into a clean disposable sample container of at least 100 ml with a watertight lid, such as a sealed specimen cup. **Proceed to Step 4.2.7**.

4.2.5 Using freshly cleaned forceps, remove the sample collection filter from the sampling cassette and place it on a clean glass microscope slide that will be used as a cutting surface. Using a freshly cleaned curved scalpel blade, cut off ½ of the filter (estimate the ½ as precisely as possible as this affects the final concentration) with a rocking motion.

4.2.6 Place the remaining portion of the original filter in archive. (Note: In cases where an initial direct preparation of an air sample was attempted and found to be overloaded, this archive portion will be approximately ¼ of the original filter.) Place ½ of the primary filter in a clean disposable sample container of at least 100 ml with a watertight lid, such as a sealed specimen cup.

4.2.7 Bring the total volume of the suspension up to approximately 90 ml using particle-free water only.

4.2.8 Adjust the suspension to a pH of 3-4 using a 10 % solution of acetic acid. Use pH paper to test.

4.2.9 Bring the total volume up to 100 ml using particle-free water and cap tightly.

4.2.10 Set up the filtration system to be used. In order to minimize the chances of contamination, only 25 mm disposable filtration funnels (such as Whatman cat. #:1922-1820) shall be used. If the filtration unit does not come pre-assembled with the necessary components (e.g. contains a glass fiber filter instead of the required MCE filter), it will be necessary to disassemble the stock cassette as it comes from Whatman and discard the glass-fiber filter. Rinse the filter unit thoroughly with particle free water and reassemble the filter unit using a cellulose support pad (Pall 66238), a 5.0µm pore size MCE diffuser filter (Enviropore FILA500A025A), and a 0.2 µm pore size MCE final filter (Enviropore FILA020A025A). Filter as usual, using restraint with the amount of vacuum applied to avoid uneven loading. Add 20 ml of particle-free water to the filtration apparatus, prior to applying vacuum and introduction of the sample suspension. When seating the filters in the filtration unit, it is essential that the vacuum be evenly applied resulting in even distribution. There should be no air bubbles or surface abnormalities anywhere in the filter assemblage. This is accomplished through wetting each successive filter as it is placed in the filtration unit and applying a light vacuum. This will assure that the filters are flat and that there are no air bubbles. Ensure that suspension is filtered within 24 hours to avoid problems associated with bacterial and fungal growth.

4.2.11 Briefly hand shake (3 seconds) the capped container containing the sample suspension.

4.2.12 Place the container in a calibrated tabletop ultrasonic bath and sonicate at 50 - 100 nW/ml for three minutes.

4.2.13 After sonication, lightly hand shake the suspension for 3 seconds, and allow it to stand undisturbed for 2 minutes to allow large particles to settle to the bottom or float to the top.

4.2.14 For each sample, prepare three secondary filters by drawing aliquots of 50 ml, 25 ml, and 10 ml. For air samples where the direct preparation is overloaded, it is acceptable to filter aliquot volumes other than the usual 10 ml, 25 ml, and 50 ml series (either greater or lesser volumes) in order to produce a sample with the highest possible f-factor without violating the overload criteria. Draw each aliquot to be filtered with the same pipette and dispense into the appropriate filter funnel. Avoid pipetting any large settled or floating particles. Apply vacuum to the filtration apparatus to draw each volume through the filter. For samples where the 10 ml aliquot filter is obviously overloaded and a secondary dilution will be required (see 4.2.15), it is not necessary to attempt to filter the 25 ml and 50 ml aliquots through 25 mm filter units.

4.2.15 If a preliminary observation of the 10 ml secondary filter appears overloaded take 10 ml of the remaining volume and dilute to 100 ml. From this secondary dilution, prepare a second series of filters using 50 ml, 25 ml, and 10 ml (corresponding to 5 ml, 2.5 ml, and 1 ml of the original suspension). Based on the original 10 ml aliquot filter loading, it is acceptable to filter aliquot volumes other than the usual 10 ml, 25 ml, and 50 ml series (either greater or lesser volumes) in order to produce a sample with the highest possible f-factor without violating the overload criteria. In some instances, it may be necessary to perform a tertiary serial dilution, taking 10 ml of the secondary dilution, adding it to 90 ml of particle free water, and filtering another series of aliquots of 10 ml, 25 ml, and 50 ml.

4.2.16 Disassemble the filtration unit. Carefully remove the filter from the filtration apparatus using fine forceps, being careful to only touch the inactive rim of the filter that has not been exposed to the sample. Place the filter in a labeled petri dish or other similar container, active side up and dry.

4.2.17 Select the secondary filter from the dilution yielding the largest possible f-factor (highest volume) which does not violate the criteria for an overloaded sample. Experience has shown that a light staining of the filter will yield a suitable preparation for analysis.

4.2.18 Perform a standard TEM sample preparation procedure.

4.2.19 If TEM examination of the lowest volume aliquot filtered is deemed overloaded, consult with the Libby laboratory coordinator (CDM) to select the most appropriate next step.

4.2.20 Place each of the unused secondary filters and the remaining portion of the selected secondary filter in archive.

4.2.21 Place any remaining sample solution in a graduated cylinder or pipet and add to a prepared 25 mm filtration unit containing a ≤ 0.22 µm/5.0 µm pore size filter set with a cellulose support pad in a disposable filtration unit with a small volume of particle free water to facilitate the production of a homogeneous solution and record the volume of sample solution added. A larger diameter (e.g. 47 mm) filtration unit with the same filter configuration may be used as needed to avoid situations where a 25 mm diameter filter may become obstructed with material. Add 10 ml particle free water to the sample container containing the residual filter and sonicate for three minutes. Add this solution to the filtration unit for the corresponding filtration unit for each sample as described in the first part of this paragraph. Do not include this 10 ml in the volume calculation of the sample solution added. This solution should then be filtered through the filtration unit and dried after removal from the filtration unit. The dried filter shall be placed an appropriate container, and labeled with the sample number, filter type, and volume applied to the filter. This filter will then be archived with the other archived filters from the sample.

4.2.22 Discard the remaining portion of the sample solution using standard laboratory protocols.

5.0 DOCUMENTATION AND ARCHIVE STORAGE

Project-specific Index IDs are recorded on all air samples. During each indirect preparation step, this Index ID is noted on the sample-specific beakers, containers, and filtration units.

In those cases where no loose material is present in the cassette or adhering to the cowl, the remaining portion of the original primary filter is placed in a suitable container and clearly labeled with the sample number and indicated that it is the original primary filter. In those cases where secondary or tertiary filters are prepared, all filters or remnants of filters will be archived into suitable containers, and clearly labeled with the sample number and the volume of the aliquot applied to each filter.

Analysis-specific details about the indirect preparation will be recorded in the sample TEM electronic data deliverable (EDD) spreadsheet. In the TEM EDD, if the sample is prepared using Procedure 1 (see Section 4.1) the preparation method should be identified as "IA – Indirect, ashed" and the appropriate inputs should be recorded in the fields provided. If the sample is prepared using Procedure 2 (see Section 4.2), the preparation method should be identified as "I – Indirect" and the appropriate inputs should be recorded in the fields provided. The spreadsheet is designed to automatically calculate the dilution factor, or f-factor, which is used in the calculation the sample air or dust concentration.

6.0 QUALITY ASSURANCE

All quality control sample results will be monitored for potential contamination. If sample results indicate cross-contamination, the laboratory will identify the affected samples and notify the USEPA Regional Chemist and project laboratory coordinator (CDM). Laboratory procedures will be re-assessed and appropriate changes will be made and documented accordingly by the project laboratory coordinator.

6.1 Lot Blanks

All cassettes utilized in the Libby project are screened for contamination by either TEM analysis or a combination of TEM and PCM analysis. One lot blank is prepared and analyzed from each carton of cassettes prior to using the lot of cassettes for sampling. The entire carton of cassettes will be rejected if any asbestos fiber is detected on the lot blank.

6.2 Filter blanks

Prior to filtration of the sample aliquot, 100ml particle-free water should be filtered. Acceptance criteria for filter blanks are as specified for laboratory blanks in the latest version of laboratory modification of LB-000029.

6.3 Plasma asher blanks

To ensure that contamination is not introduced during the ashing process, a container with an unused filter should be run as a blank with each batch of samples ashed. This sample will be prepared using the standard TEM sample preparation procedure and examined as per the established QC sequence. Acceptance criteria for plasma asher blanks are as specified for laboratory blanks in the latest version of laboratory modification of LB-000029.

7.0 DECONTAMINATION

All non-disposable equipment used during sample preparation must be decontaminated prior to use. Because the prescribed filtration units used to prepare the secondary filters are disposable, decontamination of filtration units is not required.

8.0 GLOSSARY

EDD - Electronic Data Deliverable. A Libby-specific spreadsheet designed to capture the detailed analysis and raw structure data generated during a TEM analysis. Contact the project laboratory coordinator (CDM) for the current TEM spreadsheet version.

HEPA - High Efficiency Particulate Air

MCE - Mixed Cellulose Ester

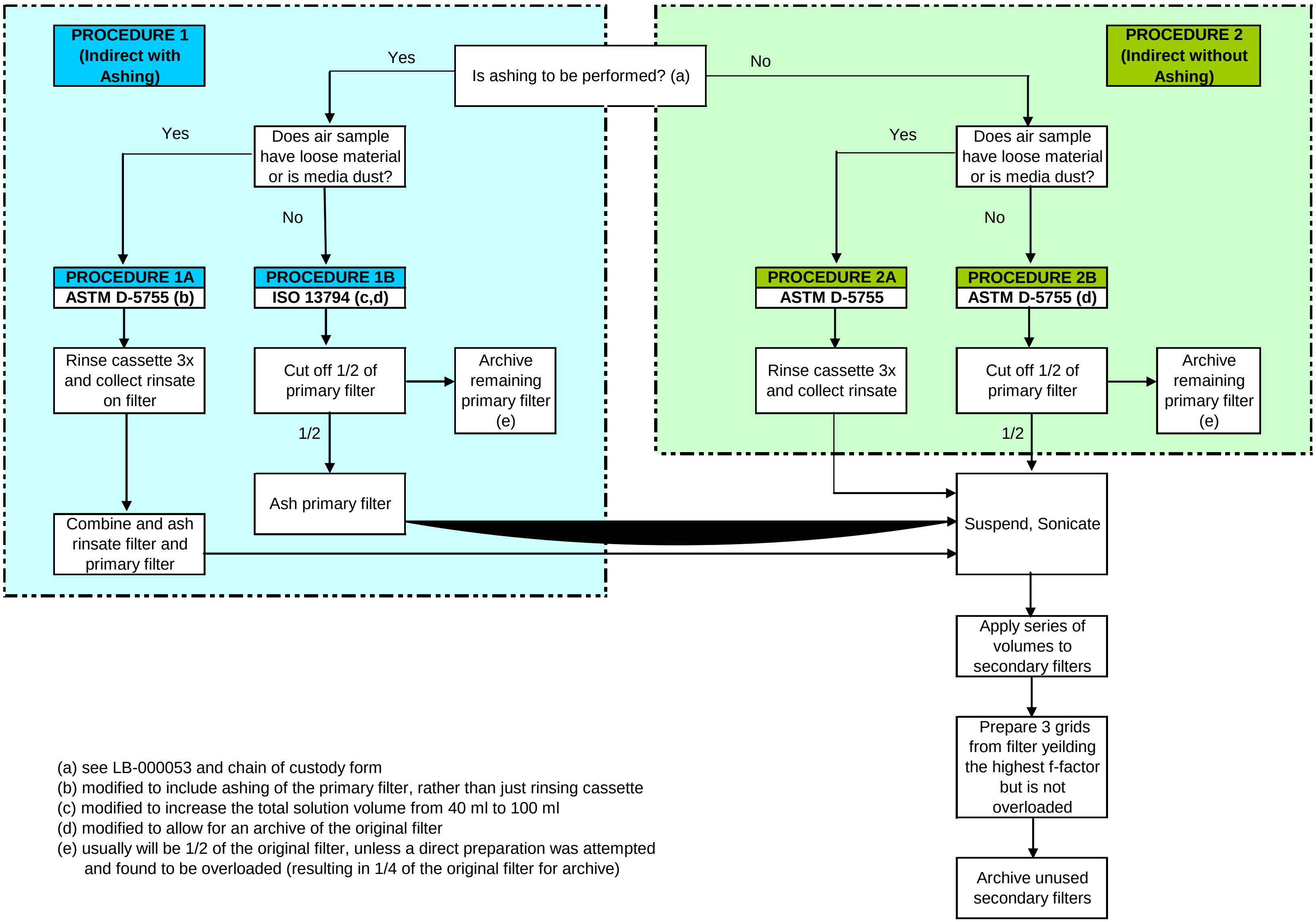
TEM - Transmission Electron Microscopy

9.0 REFERENCES

ISO 13794. Ambient air - Determination of asbestos fibres - Indirect-transfer transmission electron microscopy method. International Organization for Standardization (ISO) 13794:1999. November 15, 1999.

ASTM D-5755. Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading. ASTM D 5755-03. October 2003.

FIGURE 1. INDIRECT PREPARATION OF OVERLOADED AIR SAMPLES AND DUST SAMPLES FOR TEM ANALYSIS



(a) see LB-000053 and chain of custody form
(b) modified to include ashing of the primary filter, rather than just rinsing cassette
(c) modified to increase the total solution volume from 40 ml to 100 ml
(d) modified to allow for an archive of the original filter
(e) usually will be 1/2 of the original filter, unless a direct preparation was attempted and found to be overloaded (resulting in 1/4 of the original filter for archive)

Date: April 21, 2004 SOP No. SRC-LIBBY-01 (Rev. 2)

Title: QUALITATIVE ESTIMATION OF ASBESTOS IN COARSE SOIL BY VISUAL EXAMINATION USING STEREOMICROSCOPY AND POLARIZED LIGHT MICROSCOPY

Author Sally M. L. Gibson Syracuse Research Corporation

SYNOPSIS: A standardized method is described for the examination of the coarse fraction (>1/4") of soil samples using stereomicroscopy and polarized light microscopy (PLM) to identify, segregate, and estimate the mass percent of asbestos in the sample matrix.

Received by QA Unit:

APPROVALS:

TEAM MEMBER	**SIGNATURE/TITLE**	**DATE**
EPA Region 8	Mary Goldade	4/26/04
Syracuse Research Corp.	W J Brattin	4/26/04

Revision	Date	Reason for Revision
0	11/12/02	--
1	5/20/03	Provided clarification on dealing with very small particles.
2	4/21/04	Included statements on limitations of intended use

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized screening method for the visual examination of the coarse fraction of previously sieved soil samples for evidence of asbestos mineral content using stereomicroscopy with confirmation of asbestos content by polarized light microscopy (PLM). This SOP incorporates salient components of EPA Test Method 600/R-93/116 *Method for Determination of Asbestos in Bulk Building Materials* and National Institute of Occupational Safety and Health (NIOSH) Method 9002 *Asbestos (bulk) by PLM*, Issue 2.

This procedure will be used by employees of contractors/subcontractors supporting USEPA Region 8 projects and tasks for the Libby, Montana, site. Deviations from the procedure outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager or Regional Chemist prior to initiation of sample analysis.

2.0 PREREQUISITE TRAINING

Visual examination will be performed according to this SOP by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) and by analysts proficient either by education or experience in asbestos mineral identification by stereomicroscopy and PLM. Analyst familiarity with the procedural applications prescribed in EPA Test Method 600/R-93/116 and NIOSH Method 9002 is required.

Training as described in the Sampling and Analysis Plan, Remedial Investigation, Contaminant Screening Study, Libby Asbestos Site, Operable Unit 4, (CSS SQAPP [CDM 2002]) will be provided to laboratory personnel or laboratories with less than one year of project-specific experience by “mentors” from either Reservoir Environmental Services, Inc. or EMSL.

3.0 RESPONSIBILITIES

The CDM Laboratory Coordinator (LC) is responsible for overseeing the activities of the CDM Soil Preparation Laboratory and subcontracted laboratories performing sample analysis for the Libby, Montana, project. The LC is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the CSS SQAPP. It is the responsibility of the LC to communicate with the project personnel and subcontracted laboratory regarding specific analysis objectives and anticipated situations that require any deviation from the CSS SQAPP SOPs. In addition, it is the responsibility of the LC to communicate the need for any deviations from this SOP with the CDM Project Manager, USEPA Region 8 personnel (Remedial Project Manager or Regional Chemist.)

Subcontracted laboratory analysts performing the visual examination are responsible for adhering to the applicable tasks outlined in this SOP and substantiating components of the reference procedures (EPA 1993; NIOSH 1994) with the modifications contained herein.

4. 0 EQUIPMENT

- <u>Analytical balance</u> **-** accurate to 0.01 g, range of 0.01 g to 1000 g (for weighing total sample)

- <u>Analytical balance</u> - accurate to 1 mg (for weighing asbestos)

- <u>Traceable standards</u> - major asbestos types

- <u>Microscope</u> - binocular stereomicroscope, 5-60X approximate magnification

- <u>Microscope</u> - polarized light, binocular or monocular with a cross hair reticle (or functional equivalent) and magnification of at least 8X
  - 10X, 20X, and 40X objectives
  - 360 degree rotatable stage
  - substage condenser with iris diaphragm
  - polarizer and analyzer which can be placed at 90 degrees to one another and calibrated relative to the cross-line reticle in the ocular
  - port for wave plates and compensators
  - wave retardation plate (Red I Compensator) with ~550 nanometer retardation and known slow and fast vibration directions

- <u>Light Sources</u> - incandescent or fluorescent

- Tweezers, dissecting needles, scalpels, probes, razor knives, etc. - standard sample manipulation instruments/tools

- Microscope slides and cover slips

- Refractive index liquids

- Pre-tared glassine paper, glass plates, weigh boats, petri dishes, watchglasses, etc. - laboratory sample containers

- HEPA-filtered or Class 1 biohazard hood negative pressure

- Three-ring binder book- binders will contain Microscopic Examination Logbook Sheets (Attachment 1)

5.0 METHOD

Soils from the Libby, Montana site will be dried, sieved, and prepared according to the most recent revision of SOP ISSI-LIBBY-01, Soil Sample Preparation. The coarse fraction of the soil sample is defined as that portion of the sample which does not pass through a 1/4" sieve. The coarse fraction will be weighed, placed in a zip-top plastic bag, and labeled as described in Camp, Dresser, and McKee (CDM) SOP 1-3 (with project-specific modifications). The samples will be packaged and shipped by the soil preparation laboratory as described in CDM SOP 2-1 (with project-specific modifications) and transferred to the laboratory via chain-of-custody procedures described in CDM SOP 1-2 (with project-specific modifications).

The following sections describe the stereomicroscopic and PLM examination. Materials tentatively characterized as asbestos by stereomicroscopy will be isolated and subjected to confirmation by PLM. The mass % of Libby amphibole asbestos, other amphibole asbestos, and chrysotile asbestos in the coarse soil fraction will be calculated from the mass of each asbestos type positively identified by PLM and the original sample weight. Figure 1 provides an overview of the process.

5.1 Stereomicroscopic Examination

The laboratory will receive the coarse fraction soil samples from the CDM Soil Preparation Laboratory. The entire sample will be weighed and placed in an appropriate container. The weight of each coarse sample will be recorded, along with the sample identification, on the Microscope Examination Logbook Sheet. The sample will be subject to stereomicroscopic examination and particle segregation as depicted Figure 1. The stereomicroscopic examination to identify and segregate asbestos includes:

- using multiple fields of view over the entire sample
- probing the sample by turning pieces over and breaking clumps where possible
- manipulating the sample using appropriate instruments/tools
- observing homogeneity, texture, friability, color and extent of any observed asbestos in the sample(s)

NOTE: Although the coarse fraction is prepared by sieving with a 1/4" screen, particles smaller than 1/4" may be present in the fraction due to adherence between coarse and fine particles. This may even include some very fine asbestos fibers. Because of the technical difficulty, the analyst should not attempt to physically segregate and weigh particles smaller than about 2-3 mm (1/10 inch). A particle this size is expected to have a mass of about 10-20 mg, which is less than 0.1% of a sample whose total mass is 25 grams. If no particles larger than 2-3 mm are present, this should be noted in the data sheet for each category of asbestos using the following code system:

- ND = No asbestos observed
- Tr = Trace levels of asbestos observed but not quantified

The weight fraction for any asbestos type marked “ND” or “Tr” in a given sample is not calculated and is left blank.

As the sample is examined, the analyst will continue segregation of the sample until the entire coarse soil fraction has been characterized as either “non-asbestos” or “tentatively identified asbestos.” The tentatively identified asbestos particles will be examined by PLM, as described below. The stereomicroscopist will initial and date the Microscopy Examination Logbook Sheet.

5.2 PLM

The coarse material tentatively identified as asbestos by stereomicroscopic examination will be subject to confirmation using PLM, as described in SOP SRC-LIBBY-03 (Revision 0) ("Analysis of Asbestos Fibers in Soil by Polarized Light Microscopy"). The PLM examination will be used to confirm that the particles tentatively classified as asbestos are actually asbestos, and will be assign each particles to one of three categories:

LA = Libby amphibole
OA = Other amphibole
C = Chrysotile

If OA is observed, the type of OA observed should be noted in the data sheet using the following code system:

- AMOS = Amosite
- ANTH = Anthophyllite
- CROC = Crocidolite
- UNK = Unknown

The total weight of each type of positively identified asbestos (LA, OA, C) will be determined and recorded on the Microscopic Examination Logbook Sheet, along with the analyst's initials and the date of the examination.

6.0 QUALITY ASSURANCE

Laboratories performing the examination must be accredited by NVLAP. "Calibration" should be verifiable for each microscopist in terms of project-specific training and the successful analysis of materials of known asbestos content (NVLAP test samples, in-house standards) similar to those anticipated to be observed in Libby, Montana soils. Additionally, references such as photographs of the asbestos minerals illustrating distinguishing properties should be available benchside during characterization.

Quality control samples as described in ISSI-LIBBY-01 (i.e., preparation duplicates) will not submitted for the coarse materials samples. The entire coarse fraction will be subject to examination.

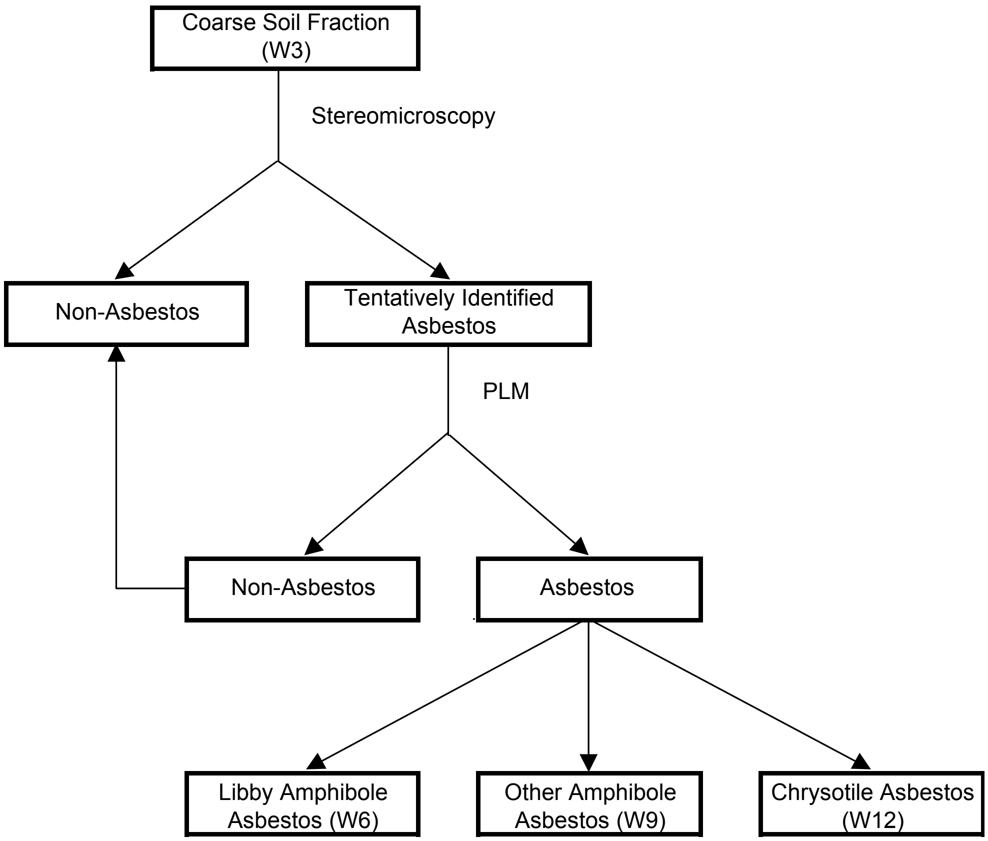
7.0 REFERENCES

CDM 2002. *Sampling and Analysis Plan, Remedial Investigation, Contaminant Screening Study, Libby Asbestos Site, Operable Unit 4.* 3282-116-PP-SAMP-14187. Camp, Dresser and McKee Denver, Colorado. April.

NIOSH 1994. National Institute of Occupational Safety and Health (NIOSH) Method 9002 *Asbestos (bulk) by PLM*, Issue 2.

USEPA 1993. *Method for Determination of Asbestos in Bulk Building Materials*. 600/R-93/116.

Figure 1. Overview of Sample Examination Process



W3 = Original coarse soil fraction mass (g)
W6 = If present in measurable quantities, mass (mg) of Libby amphibole
W9 = If present in measurable quantities, mass (mg) of other amphibole
W12 = If present in measurable quantities, mass (mg) of chrysotile

Codes used in the illustration (e.g., W3) correspond to Data Log Sheet

ATTACHMENT 1

MICROSCOPIC EXAMINATION LOGBOOK SHEET

SRC-LIBBY-01 Data sheet and EDD.xls
(Check with Volpe or SRC to determine the latest version number)

Example hard copy of data entry sheet shown on next page (for illustration purposes only).

Data Log Sheet v6 for SOP SRC-LIBBY-01

Stereomicroscopic and Gravimetric Analysis of Coarse Soil

Lab Name:

SOP Version:

Lab Job No.

Page _____ of _____

Calculated automatically in the "Electronic Data Entry" form. Do not enter data here.

EPA Index ID	Index Suffix	Lab Job-Sample No.	Status	QA Type	Total Sample Weight (g)			Analysis Details		Mass of Asbestos Particles (mg)																Comments (see Notes below)
										Libby Amphibole (LA) Asbestos				Other Amphibole (OA) Asbestos					Chrysotile (C) Asbestos							
			1 = Analyzed 2 = Missing 3 = Contam 4 = Cancelled	(Not QA)	Tare Weight (g) Empty Container	Mass of Sample + Container (g)	Mass of Sample (g)	Analyst Initials	Analysis Date	LA Qual* (ND, Tr)	Tare Weight - Container (mg)	Mass of LA + Container (mg)	Mass (mg) LA	OA Qual* (ND, Tr)	OA Type** (AMOS, ANTH, CROC, UNK)	Tare Weight - Container (mg)	Mass of OA + Container (mg)	Mass (mg) OA	C Qual* (ND, Tr)	Tare Weight - Container (mg)	Mass of C + Container (mg)	Mass (mg) C	% LA	% OA	% C	

Notes:

*Qualifier codes: ND = No asbestos observed.
Tr = Trace levels observed but not quantified.

**OA Type codes: AMOS = Amosite
ANTH = Anthophyllite
CROC = Crocidolite
UNK = Unknown

Comment Codes (user-defined):

ANALYSIS OF ASBESTOS FIBERS IN SOIL BY POLARIZED LIGHT MICROSCOPY

SYNOPSIS: A semi-quantitative method for identifying and quantifying asbestos fibers in soil using polarized light microscopy is provided. This method is based on NIOSH Method 9002, EPA Method 600/R-93/116, and CARB Method 435, with project specific modifications intended specifically for application at the Libby Superfund Site. Sampling and plan developers and data users are cautioned to understand how data are generated from this SOP.

APPROVALS:

USEPA Region 8

Signature: Mary Goldade Date: 10/10/08

Print Name: Mary Goldade

Title: Senior Environmental Scientist/Chemist

ESAT Region 8

Signature: Date: 10/10/08

Print Name: John Calanni

Title: ESAT Team Manager

Revision	Date	Principal Changes
0	3/3/2003	Initial Author: William Brattin (Syracuse Research Corporation)
1	12/11/2003	Clarified binning assignment of samples at 0.2%. Author: William Brattin (Syracuse Research Corporation)
2	10/10/2008	Complete re-design of the SOP. Provided specific requirements for sample preparation and analytical process. Authors: Douglas Kent and Nikki MacDonald, ESAT Region 8

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standard approach for semi-quantitative analysis of asbestos in samples of soil or other soil-like materials using the visual area estimation technique by Polarized Light Microscopy (PLM). This SOP is specifically intended for application at the Libby Asbestos Superfund Site and has been refined to focus testing on Libby Amphibole asbestos at levels below 1%.

2.0 SCOPE AND APPLICATION

This method is intended for analysis of asbestos in soil or other similar soil-like media in which the soil has been taken through a preparation process described below. This method is appropriate for the analysis of all types of asbestos fibers (chrysotile and amphiboles), including those that are characteristic of the Libby Asbestos Superfund Site, Libby Amphibole asbestos (LA).

3.0 RESPONSIBILITIES

3.1 It is the responsibility of the laboratory supervisor to ensure that all analyses and quality assurance (QA) procedures are performed in accordance with this SOP, and to identify and take appropriate corrective action to address any deviations that may occur during sample preparation or analysis.

3.2 The Laboratory Manager, QA/QC Coordinator (or equivalent), or Analytical Lead communicates with project managers at the United States Environmental Protection Agency ([EPA]; also referred to as the client), or their designate, any situations where a change from the SOP may be useful and/or required. The laboratory supervisor must receive approval from the EPA for any deviation or modification from the SOP before incorporating any such deviation or modification into the sample preparation and analysis process (Refer also to Section 8.2).

3.3 It is the responsibility of the laboratory to maintain a PLM SOP for Bulk Asbestos Materials, Quality Assurance Manual (QAM), Quality Management Plan (QMP), or an equivalent document(s) that meets all the requirements of the National Voluntary Laboratory Accreditation Program (NVLAP) Handbook 150. It is also the responsibility of the laboratory to ensure its testing activities stay in compliance with the requirements of NVLAP Handbook 150 and the regulatory and accrediting agencies that provide oversight of the laboratory's operations and all Libby Asbestos Site project-specific requirements.

4.0 METHOD DESCRIPTION

4.1 The test method describes a semi-quantitative analysis of asbestos in samples of soil or other soil-like materials using the visual area estimation technique by PLM, referred to as PLM-VE. The test method used for analyzing PLM asbestos samples specific to the Libby Asbestos Superfund Site is based on the National Institute of Occupational Safety and Health (NIOSH) Method 9002, EPA Method 600/R-93/116, and the State of California Air Resources Board (CARB) Method 435, with project-specific modifications provided in this SOP.

4.2 Soil samples for the Libby project are processed according to the current version of SOP ISSI-LIBBY-01, Soil Sample Preparation, before submittal to the laboratory for analysis. This process separates the coarse fraction of the soil from the fine fraction (particles passing through a ¼ inch sieve). The fine fraction is homogenized and ground to a maximum particle size of approximately 250 microns (μm). This fine fraction is further sub-divided into four fractions using a riffle splitter. One or more of these fractions is then submitted to an approved and accredited PLM laboratory for analysis. This SOP is specific to only the analysis of the fine fractions of soil samples. Coarse fractions of soil samples are analyzed according to the current version of SOP SRC-LIBBY-01, Qualitative Estimation of Asbestos in Coarse Soil by Visual Examination Using Stereomicroscopy and Polarized Light Microscopy.

4.3 The fine fraction soil sample to be evaluated for asbestos content is first examined using a low magnification stereomicroscope. Microscope slide mounts are then prepared of the sample by immersing sample material in a liquid medium of known refractive index (RI). These slide mounts are then analyzed visually by PLM. Asbestos and non-asbestos phases are identified on the basis of their morphology and optical properties. Quantification of the amount of asbestos present is done using a visual estimation approach. The concentration of LA in the sample is estimated in terms of mass fraction (percent asbestos by weight) based on the use of project-specific reference materials. Samples are re-analyzed or re-prepped and re-analyzed, and prepared standards are analyzed, as part of the quality control (QC) program.

5.0 ACRONYMS

ACM	Asbestos Containing Material
CARB	State of California Air Resources Board
EDD	Electronic Data Deliverable
EDS	Energy Dispersive Spectrometry
EDXA	Energy Dispersive X-ray Analysis
EPA	United States Environmental Protection Agency
HEPA	High Efficiency Particulate Air
LA	Libby Amphibole asbestos
LDC	Laboratory Duplicate – Cross-check
LDS	Laboratory Duplicate – Self-check
LIMS	Laboratory Information Management System
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
PE	Performance Evaluation
PLM	Polarized Light Microscopy
PLM-VE	Visual Area Estimation technique employed by Polarized Light Microscopy
PPE	Personal Protective Equipment
QA	Quality Assurance
QAM	Quality Assurance Manual
QC	Quality Control
QMP	Quality Management Plan
RI	Refractive Index
SEM	Scanning Electron Microscopy

SOP	Standard Operating Procedure
SRM	Standard Reference Material
TEM	Transmission Electron Microscopy
µm	Microns (1,000 µm = 1mm)
USGS	United States Geological Survey

6.0 HEALTH AND SAFETY

6.1 Follow general laboratory health and safety policies and regulations in the laboratory's Health and Safety Plan, Chemical Hygiene Plan, or equivalent.

6.2 All sample handling and preparation activities must be performed in a ventilated hood with an operating High Efficiency Particulate Air (HEPA) filtration system, a class 1 biohazard hood, or glove box with continuous airflow (negative pressure). Never have a sample container open except when the sample is inside of the sample preparation hood. Appropriate personal protective equipment (PPE) should be worn at all times.

6.3 Avoid repeated or prolonged contact with the RI liquids and inhalation of fumes from the RI liquids. Refer to the Material Safety Data Sheet (MSDS) forms for RI liquids for additional information and cautions.

7.0 CAUTIONS

7.1 The toxicity or carcinogenicity of each reagent (e.g., RI liquids) used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be avoided.

7.2 After processing each sample, use distilled water and paper towels to thoroughly decontaminate all work surfaces and utensils that came into contact with a sample and/or RI liquid. Never have more than one sample container open at any one time.

8.0 GENERAL LABORATORY PRACTICES

8.1 QA Program

8.1.1 Each laboratory operates under a QA program appropriate to the type, range, and volume of work it performs.

8.1.2 It is the responsibility of the laboratory to maintain a Quality Management Plan, or equivalent, in which the laboratory's QA program is detailed. Additional QA/QC requirements specific to the PLM laboratory and the Libby project are described later in Section 16.0.

8.1.3 All work is performed at a permanent laboratory location. Even if a laboratory is part of a larger organization, it is able to carry out all testing, calibration, and daily QA/QC activities independently, and at one location. There are no remote or sub-facilities where testing work is performed.

8.2 Documenting SOP Modifications

8.2.1 Any deviation from the SOP shall be documented in a laboratory modification form and then addressed in the technical Case Narrative prepared as part of the test report.

8.2.2 Additionally, when there is reason to suspect a departure from the SOP has affected the result or certainty of a measurement provided to the client, the client must be notified and informed of the nature of the departure from the SOP and the possible effect on the result or validity of the analysis. The course of action taken to keep the departure from recurring must also be discussed with the client.

9.0 PERSONNEL QUALIFICATIONS

9.1 The use of this SOP is limited to microscopists knowledgeable in the production and evaluation of asbestos data.

9.1.1 All personnel analyzing samples for the Libby project are expected to be familiar with routine chemical laboratory procedures, principles of optical mineralogy, and proficient in EPA Method 600/R-93/116, NIOSH Method 9002, and CARB Method 435.

9.1.2 Personnel at laboratories with less than one year of experience specific to the Libby Asbestos project are required to participate in the laboratory "mentoring" program to obtain additional guidance and instruction. This training is provided by personnel familiar with the particular problems and types of asbestos encountered at the Libby Asbestos Superfund Site.

9.2 Before performing any analyses, the analyst must demonstrate the ability to generate acceptable accuracy and precision with this method. This includes successfully completing NVLAP proficiency testing.

10.0 EQUIPMENT

10.1 The laboratory has all items of equipment (including instrumentation, hardware, software, and reference materials) required for the correct performance of calibrations and tests.

10.2 All equipment is properly maintained and calibrated (as appropriate) prior to use. See Section 12 for further details regarding microscope calibration.

10.3 Following is a general list of the equipment available at the PLM laboratory to perform this SOP:

10.3.1 Polarized Light Microscope, with:
- 10.3.1.1 Light source and replacement bulbs
- 10.3.1.2 Binocular observation tube
- 10.3.1.3 Blue daylight filter
- 10.3.1.4 Oculars (10X)
- 10.3.1.5 Objectives: 10X, 20X, and 40X (or similar magnification)
- 10.3.1.6 10X Dispersion Staining Objective
- 10.3.1.7 360 degree rotatable and centerable stage
- 10.3.1.8 Polarizer and analyzer aligned at 90 degrees to one another
- 10.3.1.9 Bertrand lens (optional)
- 10.3.1.10 Substage condenser with iris diaphragm
- 10.3.1.11 Accessory slot for compensator plate
- 10.3.1.12 First order red (550 nanometer) compensator plate

10.3.1.13 Crosshair reticle
10.3.1.14 Adjustment tools

10.3.2 HEPA-filtered hood, class 1 biohazard hood, or glove box with continuous airflow (negative pressure)
10.3.3 Binocular stereomicroscope, 10-50X magnification (approximate)
10.3.4 Light source for stereomicroscope
10.3.5 Muffle furnace
10.3.6 Analytical balance
10.3.7 SOP-specific Electronic Data Deliverable (EDD), most recent version
10.3.8 Mortars (agate or porcelain)
10.3.9 Pestles (agate or porcelain)
10.3.10 Anemometer
10.3.11 Wet/dry vacuum with HEPA filtration
10.3.12 Decontamination equipment (e.g. baby wipes, wet mop with bucket, etc.)

11.0 STANDARDS, REAGENTS AND SUPPLIES

11.1 High Dispersion RI Liquid from 1.620 to 1.640 (1.625 is a common choice)

11.2 1.550 High Dispersion RI Liquid

11.3 1.680 to 1.700 RI Liquid

11.4 Solid RI Standards (precision optical glass, RI from 1.48 to 1.72, in gradations of 0.01, 25 standards)

11.5 National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) 1866b - Common Commercial Asbestos consisting of chrysotile, amosite, and crocidolite

11.6 NIST SRM 1867a - Uncommon Commercial Asbestos consisting of tremolite, amosite, and anthophyllite

11.7 Controlled Performance Evaluation (PE) Reference Materials (prepared for EPA by United States Geological Survey [USGS])

11.7.1 Soils containing LA in various concentrations (provided by the client)
11.7.2 Permanently mounted slides containing 0.2% LA by mass
11.7.3 Permanently mounted slides containing 1.0% LA by mass

11.8 Controlled Libby Amphibole Asbestos (prepared for EPA by USGS), a finely-milled composite of a selected subset of 30 samples taken from the mine at the Libby Asbestos Superfund Site

11.9 NIST Bulk Asbestos Proficiency Testing Round M12001, Sample 4, a sample of un-milled rock-form winchite/richterite taken from the mine at the Libby Asbestos Superfund Site.

11.10 Non-asbestos reference materials (gypsum, calcite, fiberglass, etc.)

11.11 Instrument maintenance/calibration logbooks, document controlled

11.12 RI liquid calibration logbook, document controlled

11.13 Data recording sheet or bench sheet (Attachment 1)

11.14 RI liquid calibration conversion tables (Attachment 2)

11.15 Thermometer, NIST Traceable

11.16 Permanently mounted test slides of Anthophyllite (or other orthorhombic mineral), or the synthetic fiber polypropylene, for alignment of microscope's polars and crosshairs

11.17 Thin section of biotite for alignment of microscope's lower polar (recommended but not required)

11.18 Calibration Standards (see Sections 16.2 and 16.3)

11.19 Glass microscope slides and cover slips

11.20 Slide trays

11.21 Sampling utensils (tweezers, dissecting needles, scalpels, probes, etc.) for sample manipulation

11.22 Clean, asbestos-free sample containers (ceramic evaporating dishes, foil weighing dishes, watchglasses, etc.)

11.23 Aluminum ashing tins

11.24 Distilled water in spray bottles

11.25 Plastic re-sealable sample bags (4 mil poly bags)

11.26 Asbestos Containing Material (ACM) disposal bags

11.27 Crucible tongs

11.28 Autoclave gloves

11.29 Disposable examination gloves (latex or nitrile)

11.30 Lens paper and lens cleaning solution

11.31 Safety glasses (Z-87 rated)

11.32 Paper towels

11.33 Kimwipes (or other appropriate wiping material)

12.0 CALIBRATION AND OPTIMIZATION OF THE PLM

12.1 Equipment and Standards

12.1.1 All measuring and testing equipment having an effect on the accuracy and/or validity of analytical testing must be calibrated at frequencies described for the individual components below.

12.1.2 "Standards" refers to any material used in calibration of a piece of equipment or analytical methodology.

12.1.2.1 Standards used at the lab include slides used for alignment of a microscope's polars, optical glass for calibration of RI liquids, NIST SRMs of the various asbestos minerals, and Controlled PE Reference Materials of LA in soils.

12.1.2.2 The laboratory uses NIST-traceable standards whenever possible, or other standards that have been calibrated by a respected organization. When internal standards are used, they are checked as extensively as technically and economically feasible.

12.1.2.3 The laboratory stores its standards in such a way to avoid contamination of the standards and to protect their integrity.

12.1.2.4 Any standard that is damaged, compromised, or judged to be unreliable must be recalled from service.

12.1.2.5 Reference standards of measurement (e.g., optical glass for RI liquid calibration, slides for aligning the microscopes, and LA reference materials) are used for calibration purposes and for no other purpose.

12.1.3 Visual estimates of asbestos concentrations other than LA, as well as LA concentrations greater than 1%, are calibrated using permanently mounted working slides of known asbestos concentration prepared by the laboratory. The use of these standards is described in Section 16.0.

12.1.4 Visual estimations of LA concentrations equal to or less than 1% are calibrated using the Controlled PE Reference Materials.

12.2 General Maintenance and Calibration of the Polarized Light Microscope

12.2.1 Chrysotile, amosite, crocidolite, and anthophyllite all have the optical property of parallel extinction. Because this is one of the optical properties used to identify these minerals, the polars of the PLM must be aligned north-south (N-S) and east-west (E-W), and the polars must be kept at 90 degrees to each other.

12.2.1.1 A mineral grain's extinction angle cannot be measured accurately if the polars are not correctly aligned.

12.2.2 LA and some non-asbestos minerals (wollastonite, hornblende, etc.) will often display an inclined (or oblique) extinction angle.

12.2.3 The lower polar must be properly aligned E-W so RI's in the parallel and perpendicular directions can be measured correctly.

12.2.4 The polars should be kept at 90 degrees to each other so the field of view in crossed polars is as dark as possible.

12.2.5 The microscope's optics must be kept clean and properly aligned so optimal image quality can be produced.

12.2.6 Check the microscope's alignment each working day prior to use.

12.2.6.1 The microscope must be re-aligned any time it is found to be out of alignment. Follow all the procedures outlined in Sections 12.3

through 12.8 for re-calibrating the microscope.

12.2.7 Each day the microscope is used, record an entry in the microscope's instrument maintenance logbook. Record the date and analyst's initials confirming that all microscope alignment checks were made prior to analysis.

12.2.7.1 An individual instrument maintenance logbook must be kept for each microscope in use at the laboratory.

12.2.7.2 All maintenance activities performed on the microscope must be recorded in the appropriate logbook.

12.2.7.3 Each day the microscope is used to analyze samples, a data entry must be made in the logbook indicating that the microscope was properly calibrated that day prior to use.

12.3 Checking Microscope Alignment

12.3.1 Place a permanently-mounted test slide that contains large straight fibers of anthophyllite or polypropylene onto the microscope stage.

12.3.1.1 While looking at an empty portion of the slide under crossed polars, make sure the field of view in the microscope is as dark as possible (black, not dark gray).

12.3.1.2 When the field of view is black under crossed polars, the polars are oriented at 90 degrees to each other.

12.3.2 The fibers of anthophyllite should be completely extinct in both the N-S and E-W directions under crossed polars, indicating proper polar alignment.

12.3.2.1 Once the fibers of anthophyllite become completely extinct in either the N-S or E-W direction, pull the analyzer out to make sure the fibers of anthophyllite are still parallel to the crosshairs.

12.3.3 The stage and objectives must be centered so that a fiber centered in the field of view remains centered in view when the microscope stage is rotated.

12.3.4 The light path through the scope must be centered (specifically, the condenser and iris diaphragm must be centered on the optic axis).

12.3.5 The crosshairs should be properly oriented E-W and N-S.

12.3.6 If any of the above conditions are not met, it is necessary to re-calibrate the microscope.

12.4 Centering the Stage and Objectives

12.4.1 Because centering of the highest magnification objective (40X or 50X) is the most critical, center the microscope stage to this objective.

12.4.1.1 Adjust the centering screws on the stage so that a particle remains centered in the field of view when using the highest magnification objective as the stage is rotated.

12.4.1.2 The remaining objective lenses must be centered so they coincide with the axis of rotation of the stage.

12.4.1.3 Adjust the centering of the remaining objectives using the centering screws for each objective.

12.5 Centering the Optic Axis

12.5.1 Looking at the field of view in plane light under low magnification, insert the sub-stage condenser lens and then tighten the field iris diaphragm (not the condenser iris diaphragm) until it begins to eclipse the outer edge of the field of view.

12.5.2 Use the centering screws to center the image of the outer edge of the field diaphragm so it coincides with the edge of the field of view.

12.5.3 Tighten the field iris diaphragm until it is almost closed. With the 10X objective, only a small circle of light should be visible somewhere close to center of the field of view.

12.5.3.1 Raise or lower the microscope substage until the edge of the image of the field diaphragm comes into as sharp a focus as possible.

12.5.4 Move the substage with the condenser and its iris diaphragm using its adjusting screws until the small circle of light is centered in the field of view.

12.5.5 Open the field iris diaphragm until it is just barely wide enough that the entire field of view is illuminated.

12.5.6 Remove the sub-stage condenser lens.

12.6 Using the Condenser Iris Diaphragm

12.6.1 When viewing a microscope slide under plane light, adjust the iris diaphragm on the sub-stage condenser (not the field iris diaphragm) to improve contrast and the viewing of subtle shades and textures.

12.6.1.1 The iris diaphragm is not used for controlling brightness; the light source is used to control light and brightness.

12.7 Alignment of Lower Polar

12.7.1 Place the thin section containing large crystals of biotite on the microscope stage and examine it in plane light. This procedure allows for rapid and accurate alignment of the lower polar. Laboratories may use a different procedure to align the lower polar as long as it is documented in their internal SOPs.

12.7.2 Find a biotite crystal on the slide that exhibits strong cleavage traces between the sheets of mica.

12.7.2.1 The cleavage planes in the biotite crystal between the mica sheets should be as close to perpendicular with the plane of the slide as possible.

12.7.2.2 Crystals that show the strongest cleavage traces should have their cleavage plane at a high angle to the plane of the slide and will show the most distinctive pleochroism.

12.7.2.3 After selecting a biotite crystal, orient the slide so that the cleavage traces of the biotite crystal are directly E-W.

12.7.2.4 Observe the crystal's pleochroism as the stage is rotated.

12.7.2.5 While viewing the crystal in plane light, slowly rotate the lower polar clockwise or counter-clockwise until the biotite crystal is as dark as it will become.

12.7.2.6 When the cleavage traces of the biotite crystal are oriented directly E-W and the pleochroism of the crystal is as dark as possible, the lower polar is properly oriented E-W.

12.7.3 Rotate the ocular that contains the crosshair reticle until the crosshairs are oriented directly N-S and E-W.

12.8 Alignment of Upper Polar

12.8.1 Once the lower polar has been properly aligned E-W, place a permanently-mounted test slide containing large straight fibers of anthophyllite or polypropylene on the stage.

12.8.2 While looking at a portion of the slide relatively free of birefringent material, slowly rotate the upper polar until the field of view, under crossed polars, reaches maximum darkness. The field of view should be black, not dark gray.

12.8.3 Rotate the stage and observe the extinction of the anthophyllite or polypropylene fibers.

12.8.3.1 If the field of view is as dark as possible and the fibers become extinct in the N-S and E-W directions, the polars are properly aligned.

12.8.3.2 Once the fibers become completely extinct in either the N-S or E-W direction, pull the analyzer out to make sure the fibers are still parallel to the crosshairs.

12.8.3.3 If the polars are still not properly aligned, then repeat steps 12.7.1 through 12.8.3 until the microscope's polars are properly aligned.

12.9 Cleaning the Polarized Light Microscope

12.9.1 The oculars, objective lenses, and condenser should be cleaned whenever they become soiled with dust, oil, RI liquids, etc. At minimum, they shall be cleaned monthly.

12.9.2 Always use lens cleaning solution and lens paper to clean the lenses.

12.9.2.1 Do not use a dry cloth because this can scratch the surfaces of the lenses.

12.9.2.2 Avoid applying excessive pressure to the lens surface when cleaning as this could also scratch the lens.

12.9.2.3 Never use any solvents (such as alcohol, etc.) other than lens cleaning solution because this can dissolve the cement that holds the lenses together.

12.9.3 If dust gets inside the microscope, it is necessary to completely disassemble and clean the microscope.

12.9.3.1 The microscope must be re-calibrated after being re-assembled and this must be recorded in the microscope's maintenance logbook.

12.9.3.2 Disassembly of the microscope should only be performed by qualified personnel.

13.0 DETAILED METHOD FOR ASBESTOS TESTING OF SOIL AND SOIL-LIKE MATERIALS

13.1 Stereomicroscopic Examination

13.1.1 All sample preparation activities, including stereomicroscopic examination, slide mounts, etc., must be performed in a HEPA-filtered hood, class 1 biohazard hood, or glove box with continuous airflow (negative pressure).

13.1.2 Due to the sample preparation requirements described in the current revision of SOP ISSI-LIBBY-01, Soil Sample Preparation, samples should never be wet. If the sample is wet, contact EPA or designate.

13.1.3 The stereomicroscope is a low magnification microscope (approximately 10X-50X) used for visual examination of specimens at a coarse scale.

Stereomicroscopic examination is especially useful for soil samples where fibers may be unevenly or thinly distributed throughout the sample.

13.1.4 Begin the analysis by pouring the entire sample out of its container onto a clean, asbestos-free substrate, such as an agate mortar, ceramic evaporating dish, watchglass, weighing dish, etc.

13.1.4.1 For fine-ground soil samples, the mass of the sample will ideally be 20 to 50 grams; however, some samples submitted to the laboratory may be larger.

13.1.5 With the stereomicroscope, visually examine the entire sample for homogeneity and the presence of any suspect fibers.

13.1.6 If individual fibers suspected of being asbestos are observed, pick out one or more of these fibers with fine forceps (or other appropriate utensil) and mount them on a glass microscope slide in an appropriate RI liquid. These sample preparations are often called "fiber-picks" and are referred to as fiber-picks in this SOP.

13.1.6.1 Each microscope slide must be wiped with lint-free wipes prior to use to avoid contamination.

13.1.6.2 Mount individual fibers in 1.550 RI oil if chrysotile is suspected, 1.620 to 1.640 RI oil if LA or anthophyllite is suspected, or 1.680 to 1.700 RI oil if amosite or crocidolite is suspected.

13.1.6.3 Only one drop of RI liquid is necessary to prepare the fiber-pick slide.

13.1.6.4 Cover this preparation with a glass cover slip and identify the fibers using PLM analysis techniques (see Section 13.5).

13.1.7 Record all stereomicroscopic findings, including sample appearance, an initial estimated percent LA, and an initial estimated percent other asbestos (chrysotile and other amphibole), in the appropriate fields on the analytical bench sheet.

13.1.7.1 Stereomicroscopic examination does not provide positive identification of asbestos fibers. Later analysis by PLM will confirm, deny, or refine the preliminary estimated percent asbestos.

13.1.7.2 The procedure for performing a calibrated visual estimate using both stereomicroscopy and PLM is described in Section 13.7.4 and Attachment 8.

13.1.8 Even if no fibers are visible, prepare the sample as described in Section 13.3.

13.2 Determination of Ashing the Sample

13.2.1 Soil samples containing a significant amount of twigs, leaves, tar, or other debris may need to be ashed prior to being prepared for random mounts for PLM.

13.2.1.1 Excessive cellulose fibers, tar or asphalt may obscure asbestos fibers, and ashing will assist in eliminating this interference.

13.2.2 Ashing consists of placing a representative portion of the whole sample into the muffle furnace to burn off organics that obscure asbestos fibers or keep the sample from breaking up on the slide during mounting. Approximately 480°C is hot enough to burn off organics without destroying the crystallinity of asbestos fibers. Do not ash the entire sample because a re-analysis of the sample may be required at a later date.

13.2.3 The ashed residue can then be examined under the stereomicroscope following the procedures in Section 13.1, above, and slide mounts can be prepared from the ashed residue for PLM analysis, according to the procedures in Section 13.3, below.

13.2.4 Following PLM analysis, calculate the percentage of asbestos in the pre-ash sample using the equation below:

Pre-ash percent asbestos = (percent asbestos in ashed residue) * (C-A)/(B-A)

Where:

A = weight of ashing tin in grams
B = weight of sample + ashing tin in grams (pre-ash)
C = weight of sample + ashing tin in grams (post-ash)

13.2.5 Record the required gravimetric measurements and calculations listed above in Section 13.2.4 on the analytical data sheet in the comments field. Alternatively, attach a separate analytical data sheet (specific to ashing samples) with the necessary measurements, and indicate the attachment in the comments section.

13.3 Preparation of Samples for PLM Visual Area Estimation

13.3.1 Quantitative analysis preparation typically consists of preparing random mounts of a sample. The objective is to produce random mounts of a representative sub-sample from the original sample.

13.3.2 View the sample through the stereomicroscope to determine if it is sufficiently homogenized and all particles are reduced to a small enough size.

13.3.2.1 Soil samples processed according to the current revision of SOP ISSI-LIBBY-01, Soil Sample Preparation, should be ground to a maximum particle size of approximately 250 μm.

13.3.2.2 Additional homogenization of the sample at the laboratory using a mortar and pestle may be required if any remaining inhomogeneities or coarse particles are observed in the sample. When further grinding the sample, care should be taken to not pulverize the LA to a fiber size unidentifiable by PLM techniques. The material in the slide mounts must be coarse enough that fibers of LA can still be identified by PLM and still be as representative as possible of the sample as a whole.

13.3.3 Oil immersion mounts of randomly selected sub-samples of the homogenized material are prepared in RI liquids for PLM analysis.

13.3.3.1 Prepare a minimum of five random mount slides for each sample.

13.3.3.2 Each microscope slide must be wiped clean with an appropriate wipe prior to use in order to avoid contamination.

13.3.3.3 Place one to two drops of the appropriate RI liquid onto each slide.

13.3.3.3.1 Prepare at least two slides with a RI liquid in the range of 1.620 to 1.640 for easier measurement of the optical properties of LA. Generally, 1.625 RI liquid is used for LA.

13.3.3.3.2 The refractive indices of the oils used for the remaining slides is left to the analyst's discretion based upon the suspected mineralogy present in the sample material.

13.3.3.4 Use a spatula, the curved edge of a scalpel blade, or other similar utensil to collect randomly selected sub-samples of the homogenized sample material, and place this into the RI liquid on the slides.

13.3.3.5 With the utensil, gently stir the sample material in the RI liquid to produce a homogeneous mixture.

13.3.3.6 Cover each mixture of RI liquid and sample material with a glass cover slip.

13.3.3.7 Gently agitate the mixture under the cover slip by pressing down and rubbing the top of the cover slip with something that will "grab" the cover slip and allow it to be translated from side to side, such as an etching scribe or the eraser end of a pencil.

13.3.3.7.1 Use this action to spread the mixture of RI liquid and sample material over the approximate area of the cover slip.

13.3.3.7.2 The material under the cover slip should be spread out evenly with no or very few overlapping particles.

13.3.3.8 Wipe any loose sample material or excess RI liquid from the slide with lint-free wipes.

13.3.3.9 The prepared slide can now be safely removed from the hood for analysis by PLM.

13.4 Supplemental Stereomicroscopic Evaluation

13.4.1 Following random slide mount preparation, it may be useful agitate or tap the sample container to cause the particulate to settle and the amphibole fibers to sort to the surface.

13.4.1.1 Re-examine the sample using the stereomicroscope, and repeat procedures 13.1.6, above.

13.4.1.2 This "tapping" method should only be used as a qualitative technique following random slide mount preparation, and not as a quantitative technique, because it tends to make the sample inhomogeneous.

13.4.1.3 The representative sub-sample material used for preparing random slide mounts must remain homogeneous.

13.4.2 Avoid contamination by maintaining a clean work space.

13.4.2.1 After preparing each sample, clean all work surfaces, sample substrates, utensils, and any other items that come into contact with the sample, with distilled water and paper towels.

13.4.2.2 Dispose of gloves after they become excessively dirty.

13.4.2.3 Only prepare one sample at a time. Never have more than one sample container open inside the preparation hood at any given time.

13.4.2.4 When placing drops of RI liquid on the slides, never touch the Dropper directly to a different RI oil or to oil that already has sample material in it. Only touch the dropper to a clean slide.

13.4.2.5 Discard any RI liquids that become contaminated with sample debris.

13.5 Classification of Asbestos Mineral Type

13.5.1 Analysis of Libby soil samples consists of identification and quantification of any and all asbestos phases present within the sample, and when possible, the identification and semi-quantification of non-asbestos fibers and the identification of matrix materials within the sample.

13.5.2 Positive identification of asbestos, non-asbestos fibers, and matrix material is conducted by examination of sample slide mounts by PLM.

13.5.3 Visually examine the entire area of all prepared slides using PLM (using both plane light and crossed polars) to find any fibrous constituents within the slide mounts.

13.5.4 Positive identification of asbestos requires the determination of the following six optical properties by PLM.

13.5.4.1 Morphology

13.5.4.2 Color and pleochroism (if pleochroism is present)

13.5.4.3 Refractive indices, both alpha and gamma

13.5.4.4 Birefringence

13.5.4.5 Extinction characteristics

13.5.4.6 Sign of elongation (positive if the fiber is length slow, negative if the fiber is length fast)

13.5.5 Asbestos cannot be reported in any quantity, including trace, until its optical properties have been measured and recorded.

13.5.6 Based on the optical properties, asbestos in the sample is classified into one of three categories described in Table 13.1:

Table 13.1

Code	Description	Notes
LA	Libby Amphibole	The minerals winchite, richterite, tremolite, and actinolite, which are characteristic of the mine at the Libby Superfund Site. Also included are the minerals magnesio-arfvedsonite and magnesio-riebeckite, which are known to occur at the Libby Asbestos Superfund Site in smaller quantities.
OA	Other amphibole asbestos	Regulated amphibole asbestos (amosite, crocidolite, and anthophyllite) that are not thought to occur in significant amounts at the mine in Libby.
C	Chrysotile	Asbestiform serpentine

13.5.7 Chrysotile $Mg_3Si_2O_5(OH)_4$

13.5.7.1 Serpentine is a phyllosilicate (sheet-silicate) mineral, and when serpentine occurs in an asbestiform morhology, it is referred to as chrysotile.

13.5.7.2 There are three varieties of the mineral serpentine: antigorite, lizardite, and chrysotile. All three have the same chemical composition but different morphologies.

13.5.7.3 Individual fibrils of chrysotile have been shown by transmission electron microscopy (TEM) to be in the form of scrolled tubes, or tightly rolled micaceous sheets, such that the fibril axis lies within the plane of the sheets (much as if a newspaper had been rolled up). In other types of serpentine, the sheets may be curved, but they are flat or platy, not rolled into tightly scrolled tubes.

13.5.7.4 If serpentine is observed and has a platy or massive (non-fibrous) morphology, it is classified as non-asbestiform serpentine (antigorite if it is platy or lizardite if it occurs as a massive, fine-grained matrix) and not as asbestos (chrysotile).

13.5.7.5 If serpentine is observed and has a fibrous morphology, it is classified as chrysotile asbestos.

13.5.7.6 The morphology of chrysotile is fibrous and sometimes silky.

13.5.7.7 The fibers are flexible. Chrysotile sometimes occurs as tangled mats of many fibers.

13.5.7.8 Chrysotile can only be seen in PLM as chrysotile bundles; the individual fibrils that make up a chrysotile bundle are beyond the resolution of all light microscopy.

13.5.7.9 Bundles of chrysotile are often splayed.

13.5.7.10 Kinked chevron-style folds are sometimes seen in chrysotile.

13.5.7.11 Chrysotile is usually colorless in PLM, although it sometimes shows a slight golden, yellow, or pale golden-green color in PLM.

13.5.7.12 Chrysotile that has been exposed to very high temperatures is distinctly brown under plain light.

13.5.7.13 Chrysotile is never pleochroic.

13.5.7.14 Small particles of opaque magnetite can sometimes be seen in large, intact bundles of chrysotile.

13.5.7.15 The range for the lower RI (alpha, or α) for chrysotile is 1.545 to 1.553 as reported in the certificate for NIST SRM 1866b, although the range for chrysotile encountered in field samples may be somewhat wider.

13.5.7.16 The range for the higher RI (gamma, or γ) for chrysotile is 1.552 to 1.560 as reported in the certificate for NIST SRM 1866b, although the range for chrysotile encountered in field samples may be somewhat wider.

13.5.7.17 Exposure to high heat and dehydration of the crystal lattice will increase the refractive indices of chrysotile.

13.5.7.18 The birefringence (expressed numerically as δ, the difference between α and γ) of chrysotile is low, usually around 0.008. In practice, this means that most chrysotile bundles of fine to medium size observed in samples will have low first order gray to medium gray interference colors under crossed polars. Larger, thicker fibers can show first order white to yellow interference colors; higher colors may be seen in the thickest bundles.

13.5.7.19 Chrysotile is most easily visible in plane light in the higher RI liquids, such as 1.62 or 1.68. However, measurement of the refractive indices of chrysotile should be done with the fibers mounted in the 1.550 oil.

13.5.7.20 Chrysotile is almost always length slow (positive sign of elongation), although length fast chrysotile has been observed on very rare occasions.

13.5.7.21 Chrysotile invariably has parallel extinction.

13.5.8 Amosite $Fe_7Si_8O_{22}(OH)_2$

13.5.8.1 The name amosite is derived from an acronym for “Asbestos Mines of South Africa”. It is a trade name and not a mineralogical name. Amosite is the fibrous variety of the mineral grunerite.

13.5.8.2 Amosite has an acicular (needle-like) morphology. Bundles of amosite are composed of many lesser needles of amosite. Needles of amosite are often straight and only somewhat flexible.

13.5.8.3 Amosite is usually colorless, green, brown, or greenish-brown in plane light. Heated amosite is brown to dark brown and can be nearly opaque. Amosite is sometimes weakly pleochroic.

13.5.8.4 The range for the lower RI (α) for amosite is 1.675 to 1.681 as reported in the certificate for NIST SRM 1866b, although the range for amosite encountered in field samples may be somewhat wider.

13.5.8.5 The range for the higher RI (γ) for amosite is 1.697 to 1.704 as reported in the certificate for NIST SRM 1866b, although the range for amosite encountered in field samples may be somewhat wider.

13.5.8.6 Exposure to high heat and dehydration of the crystal lattice will increase the RI's of amosite.

13.5.8.7 The birefringence of amosite is moderate, usually about 0.020. Most fibers observed will have first order white to yellow interference colors under crossed polars; although, higher colors (first order magenta to second order or sometimes even higher) can be seen in the thicker bundles.

13.5.8.8 RI measurements should be done with the fibers mounted in 1.680 to 1.700 RI oil.

13.5.8.9 Amosite is length slow (positive sign of elongation).

13.5.8.10 Even though grunerite is a monoclinic mineral, the extremely fine fibers that form bundles of amosite cause amosite to have parallel extinction.

13.5.9 Crocidolite $Na_2Fe_3^{2+}Fe_2^{3+}Si_8O_{22}(OH)_2$

13.5.9.1 Crocidolite is a fairly uncommon type of asbestos.

13.5.9.2 Crocidolite has an acicular morphology very similar to that of amosite. The fibers are only somewhat flexible.

13.5.9.3 Crocidolite is distinctly blue or blue-green in plane light and is pleochroic.

13.5.9.4 Normally, the range for the lower RI (α) for crocidolite is 1.680 to 1.698 (EPA, 1993).

13.5.9.5 Normally, the range for the higher RI (γ) for crocidolite is 1.685 to 1.706 (EPA, 1993).

13.5.9.6 The strong color of crocidolite makes measurement of the refractive indices very difficult. For this reason, select finer fibers of crocidolite, which have less color, when measuring refractive indices.

13.5.9.7 The birefringence of crocidolite is low, usually about 0.006. Crocidolite often shows anomalous interference colors under crossed polars.

13.5.9.8 RI measurements on crocidolite should be done with the fibers mounted in 1.680 or 1.700 oil.

13.5.9.9 Because crocidolite is length fast, the lower RI (α) should be measured with the fiber oriented in the E-W direction (parallel to the lower polar), and the higher RI (γ) should be measured with the fiber oriented in the perpendicular (N-S) direction.

13.5.9.10 Even though riebeckite is a monoclinic mineral, the extremely narrow fibers that form bundles of crocidolite cause crocidolite to have parallel extinction.

13.5.10 Anthophyllite $(Mg,Fe)_7Si_8O_{22}(OH)_2$

13.5.10.1 Anthophyllite occurs as straight to slightly curved fibers or fiber bundles. The morphology of anthophyllite is lamellar to acicular.

13.5.10.2 Anthophyllite is a rare type of asbestos used in construction materials.

13.5.10.3 Anthophyllite is colorless to pale brown in plane light. It is sometimes weakly pleochroic.

13.5.10.4 The range for the lower RI (α) for anthophyllite is 1.593 to 1.694 (Deer et al., 1997). The commercial-grade anthophyllite in SRM 1867a has an α of 1.615.

13.5.10.5 The range for the higher RI (γ) for anthophyllite is 1.613 to 1.722 (Deer et al., 1997). The commercial-grade anthophyllite in SRM 1867a has a γ of 1.636.

13.5.10.6 The birefringence of anthophyllite is moderate, usually about 0.020.

13.5.10.7 Generally, RI measurements on anthophyllite should be done with the fibers mounted in 1.620 to 1.640 oil.

13.5.10.8 Because anthophyllite is an orthorhombic mineral, all fibers of anthophyllite will invariably have parallel extinction. This helps to distinguish it from LA and the non-asbestos mineral wollastonite, which often show inclined extinction.

13.5.10.9 Anthophyllite is length slow (positive sign of elongation).

13.5.11 Libby Amphibole

13.5.11.1 LA consists of Tremolite-Actinolite, $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$, Winchite, $CaNaMg_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$, Richterite, $NaCaNa(Mg,Fe)_5Si_8O_{22}(OH)_2$, Magnesio-arfvedsonite, $(Na,K)Na_2Mg_4Fe^{3+}Si_8O_{22}(OH)_2$, and Magnesio-riebeckite, $Na_2Mg_3Fe^{3+}{}_2Si_8O_{22}(OH)_2$.

13.5.11.2 LA is a term used to categorize a group of minerals generally described as sodic tremolite. The solid solution series of sodic tremolite is comprised of a group of minerals, such as tremolite, actinolite, winchite, richterite, magnesio-riebeckite, and magnesio-arfvedsonite. The optical properties for each individual mineral are provided below and in Attachment 4. As seen, there is a great deal of overlap in optical properties among the minerals that make up LA. As such, discreet mineral identification is not required by this SOP. Rather, if the sample exhibits the optical properties of a mineral listed in this section, the specific optical properties (such as refractive indices, birefringence, extinction angle, and sign of elongation) shall be noted on the analytical data sheet and EDD, and the mineral identified as LA.

13.5.11.3 The morphology of LA ranges from prismatic to fibrous. The fibers that form a bundle of LA may be parallel to sub-parallel, or the fibers may sometimes cross one another at various angles giving the bundle a matted appearance. The aspect ratio of the fibers is highly variable, and all tremolite, actinolite, winchite, richterite, magnesio-arfvedsonite or magnesio-riebeckite encountered in a sample should be classified as LA regardless of the aspect ratio of the individual fibers. Refer to Attachment 5 for photomicrographs that show a wide range of LA morphologies that may be encountered during PLM analysis.

13.5.11.6 Laboratories should use the Controlled Libby Amphibole Asbestos and NIST Bulk Asbestos Proficiency Testing Round M12001, Sample 4, as reference materials to familiarize themselves with the range of habits and optical properties of LA. Laboratories should contact the client or their designate if they do not have these reference materials.

13.5.11.7 Color of LA in plane light is highly varied. Tremolite is usually colorless in plane light. Actinolite is usually pale green to dark green. Darker colors and stronger pleochroism are associated with higher iron content for the tremolite-actinolite series (Deer et al., 1997). Winchite can be pale yellow, blue, blue-green, or blue-gray. Richterite can be brown, tan, pale green to dark green, pale yellow, or violet (Deer et al., 1997). Magnesio-arfvedsonite in plane light is yellowish green, brownish green, or grey-blue (Deer et al, 1997). Magnesio-riebeckite in plane light is blue, grey-blue, or pale blue to yellow (Deer et al, 1997). Winchite, richterite, magnesio-arfvedsonite, and magnesio-riebeckite can all be pleochroic.

13.5.11.8 LA generally has moderate birefringence, usually about 0.015 to 0.02.

13.5.11.9 LA usually shows inclined (or oblique) extinction, although fibers in certain crystallographic orientations will exhibit parallel extinction. The maximum extinction angle for tremolite-actinolite can be as high as 10 to 21 degrees. Winchite and richterite can show higher extinction angles, sometimes as high as approximately 30 degrees or even higher for richterite.

13.5.11.10 RI measurements on LA should be done with the fibers mounted in 1.620 to 1.640 RI oil (1.625 is a commonly-used choice).

13.5.11.11 Winchite, richterite, tremolite, and actinolite are all length slow (positive sign of elongation). Both magnesio-arfvedsonite and magnesio-riebeckite are length fast (negative sign of elongation).

13.5.11.12 On the analytical bench sheet (Attachment 1), record only one set of optical properties for LA for each sample that contains LA. Choose the fiber/and or bundle that shows the best Becke line and/or dispersion staining colors.

13.5.11.13 Refer to Attachment 4, Optical Properties of Fibrous Amphiboles, for additional information on the optical properties of LA used in LA identification.

13.6 Refractometry

13.6.1 Calibration of Refractive Index Liquids

13.6.1.1 Accurate measurement of a mineral’s refractive indices begins with proper calibration of the RI liquids. Each RI liquid used for routine sample preparation and analysis must be calibrated once each month.

13.6.1.2 Prepare an oil immersion mount of the appropriate certified precision optical glass in the oil to be calibrated.

13.6.1.3 Read the laboratory’s thermometer to the nearest 2° C to determine the ambient temperature t, and record the temperature on the appropriate worksheet (see page 7 of Attachment 3).

13.6.1.4 Next determine λ_0. This is the wavelength at which the RI of the oil is equal to the RI of the certified precision optical glass. Observe the central stop dispersion staining color shown by the glass, and consult the dispersion staining color chart (McCrone, 1987). If the glass particles show a range of dispersion staining colors, use the most predominant color when determining λ_0. Record the predominant dispersion staining color and corresponding λ_0 on the worksheet.

13.6.1.5 Consult the Excel spreadsheet developed by Shu-Chun Su, Ph.D., "Create_RI_Liquid_Calibration_Conversion_Tables.xls", for the appropriate conversion table (see Attachment 2). These tables are used to convert λ_0 and t into n_d^{25}, which is the calibrated RI of the oil at a wavelength of 589 nm and a temperature of 25°C. Determine the value of n_d^{25} from the appropriate table for the known values λ_0 and t.

13.6.1.6 Additional conversion tables for oils not included in the spreadsheet can be generated by entering the dispersion coefficients and values of n_d of the oil and the glass, and the value of dn/dt (change of RI with temperature) of the oil into the first sheet of the workbook. All of these values are clearly provided by the manufacturer of the glass and oil.

13.6.1.7 Record the value of n_d^{25} on the worksheet. This is the calibrated RI of the oil at a standard temperature of 25°C.

13.6.1.8 Write this calibrated RI and the date of calibration on the bottle.

13.6.1.9 If the difference between the actual calibrated RI of the oil and the original RI of the oil is greater than 0.004, then the oil may not be used for analysis of samples.

13.6.1.10 Repeat the above steps for each oil in routine use.

13.6.2 Measurement of refractive indices (refractometry) of minerals is performed using either the Dispersion Staining Method or the Becke Line Method.

13.6.2.1 All analysts must be proficient in both methods. The choice of which method to use is left to the analyst's discretion.

13.6.2.2 The dispersion staining method requires a clean surface of the mineral to be in direct contact with the oil and can only be performed if a conversion chart has been developed beforehand for a specific mineral in a specific RI liquid.

13.6.2.3 The Becke Line Method will often work on relatively fine fibers, and also requires a clean surface of the mineral to be in contact with the oil. However, this method does not require a specific mineral-oil chart to be developed before it is used. For this reason the Becke Line method can be used to measure the RI's of other materials besides LA and regulated asbestos minerals.

13.6.3 Measurement of Refractive Indices by the Dispersion Staining Method

13.6.3.1 Mount the fibers in the appropriate oil (1.550 for fibers suspected of being chrysotile, 1.620 to 1.640 oil for fibers suspected of being LA or anthophyllite, or 1.680 to 1.700 oil for fibers suspected of being amosite or crocidolite).

13.6.3.2 In order for the correct dispersion staining colors to be displayed, a clean surface of the mineral must be in direct contact with the RI liquid.

13.6.3.3 If may be necessary to separate and spread out fibers bundles on the slide so a clean surface is exposed. Do this by agitating the bundles with an X-acto knife or other sample manipulation utensil, or rubbing the cover slip over the bundles to agitate and dis-aggregate them.

13.6.3.4 Examine the slide in plane light using the 10X dispersion staining objective. The dispersion staining objective and its central stop should be centered.

13.6.3.5 Stop down the condenser iris diaphragm until dispersion colors are observed.

13.6.3.6 Read the thermometer to find ambient temperature of the laboratory's air to the nearest 2°C.

13.6.3.7 To measure α, orient the fiber E-W (parallel to the lower polar) if the fiber is suspected of being crocidolite, or N-S if the fiber is suspected of being chrysotile, amosite, or anthophyllite. LA shows biaxial optics and requires a more detailed treatment, described below in Section 13.6.5.

13.6.3.8 Next, observe the dispersion staining color that is displayed.

13.6.3.9 Light of a wavelength higher or lower than the matching wavelength (given the symbol λ_0, where the RI of the oil matches the RI of the mineral) is refracted around the central stop and passes through.

13.6.3.10 Light of a wavelength equal or approximately equal to the matching wavelength is blocked.

13.6.3.11 The observed color is the summation of the remaining light.

13.6.3.12 Consult the dispersion staining color chart (McCrone, 1987) and find the matching wavelength (λ_0) that corresponds to the observed color.

13.6.3.13 When measuring α and a range of dispersion staining colors is displayed, choose the color that produces the lowest RI, i.e., the color that corresponds to the longest λ_0.

13.6.3.14 Refer to the paper "Rapidly and Accurately Determining Refractive Indices of Asbestos Fibers by Using Dispersion Staining Method", by Shu-Chun Su, Ph.D. (1996).

13.6.3.15 For the appropriate RI oil and mineral combination, find the column for the laboratory's temperature and row for λ_0; record the corresponding value of RI.

13.6.3.16 To measure γ, rotate the stage 90 degrees.

13.6.3.17 The fiber should now be perpendicular to the lower polar (N-S) if the fiber is suspected of being crocidolite, or parallel to the lower polar (E-W) if the fiber is suspected of being chrysotile, amosite, or anthophyllite. Refer to Section 13.6.5 for orienting fibers of LA when measuring γ.

13.6.3.18 Observe the dispersion staining colors and find the corresponding $\lambda_{0.}$ When measuring γ, choose the color that produces the highest RI, i.e., the color that corresponds to the shortest λ_0.

13.6.3.19 Consult the appropriate chart for the asbestos type and oil being used; record the value of RI for the temperature and λ_0.

Note: *There are two charts for each mineral and oil combination - one for α and one for γ. Be sure to use the appropriate chart when measuring α or γ.*

13.6.4 Measurement of Refractive Indices by the Becke Line Method

13.6.4.1 Becke line colors are observed in plane light when the RI of the mineral is close to or the same as the RI of the oil. Becke line colors are usually best observed using high magnification (200X to 500X).

13.6.4.2 To measure refractive indices using the Becke line method, mount the fibers in an oil whose RI is close to that of the mineral.

13.6.4.3 Observe the Becke line colors with the fiber oriented in the parallel and perpendicular directions.

13.6.4.4 As a rule, the Becke line moves into whichever medium (the grain or the oil) that has a higher RI when the microscope stage is lowered from the focused position.

13.6.4.5 Colored Becke lines are produced when the RI of the grain is higher than the oil for some wavelengths of light in the visible spectrum and when the RI of the grain is less than the oil for other wavelengths.

13.6.4.6 If a brownish or rust colored Becke line moves into the grain when the microscope stage is lowered, and a bluish-white Becke line moves into the oil, the RI of the grain is less than that of the oil.

13.6.4.7 If an orange-yellow, yellow, or lemon-yellow Becke line moves into the grain when the stage is lowered, and a violet or blue-violet Becke line moves into the oil, the RI of the grain is higher than that of the oil.

13.6.4.8 A perfect match occurs when n_d (the RI for the wavelength of sodium light, 589 nm) is the same for both the grain and the oil. When the n_d of mineral matches the n_d of the oil, an orange Becke line with just a touch of red moves into the grain and a bluish line moves into the oil when the stage is lowered.

13.6.4.9 If a perfect match cannot be obtained, mount the mineral in two oils that bracket the RI of the mineral, and interpolate where the RI of the mineral should be.

13.6.4.10 The Becke Line Chart by F. D. Bloss (1999) may be used to approximate the size of the difference between the RI of the oil and the RI of the mineral.

13.6.5 Biaxial Optics

13.6.5.1 Anthophyllite and LA often show biaxial optics. This is rarely a consideration for amosite or crocidolite.

13.6.5.2 Even though chrysotile is a monoclinic mineral, it does not show biaxial optics because of the scrolled nature of the fibers.

13.6.5.3 When an asbestos fiber shows biaxial optics, it is easy to measure a RI called α' that is between true α and beta (β) when attempting to measure α.

13.6.5.4 True α can only be observed when a crystal is oriented in exactly the correct position.

13.6.5.5 For the monoclinic minerals that display biaxial optics (LA), the crystals need to be oriented so the X and Z axes of the biaxial indicratix corresponding to the directions of α and γ are parallel to the lower polar when measuring these indices, and they are not necessarily oriented with the crystallographic axes. As a general rule, when these fibers show inclined extinction, select the fibers that show the highest extinction angle when measuring α and γ. RI measurements should be made on a fiber where the plane of X and Z in the biaxial indicatrix lies as close to parallel to the plane of the microscope stage as possible, such that the microscopist is looking directly down Y, which corresponds to the β RI (and also the b crystallographic axis for tremolite, actinolite, winchite, richterite, and magnesio-arfvedsonite). Fibers at or close to this orientation will tend to show the highest extinction angle.

13.6.5.6 Next, when measuring α for LA, orient the fiber approximately N-S, at the orientation where the fiber is extinct under crossed polars. The fiber should now be oriented away from N-S at an angle that is equal to its extinction angle.

13.6.5.7 Repeat this for a number of crystals. If the crystals show different Becke line colors or dispersion staining colors, measure α for the crystals that display the lowest RI.

13.6.5.8 Similarly, it is easy to measure a RI called γ' that is between β and true γ when attempting to measure γ. True γ can only be observed when a crystal is oriented in exactly the correct position.

13.6.5.9 Orient a fiber of LA approximately E-W, so that the fiber is extinct under crossed polars, when measuring γ. The fiber should now be oriented away from E-W at an angle equal to its extinction angle, so that the Z direction of the biaxial indicatrix is parallel to the lower polar. Repeat this for a number of crystals. If the crystals show different Becke line colors or dispersion staining colors, measure γ for those that display the highest RI.

13.6.5.10 Biaxial Optics of Anthophyllite

13.6.5.10.1 When measuring α (the lower RI) for anthophyllite, the fiber should be oriented in the perpendicular (N-S) direction. When fibers of anthophyllite are oriented in the N-S position, they can show either α or β, or anywhere in between, depending on their orientation. It is therefore necessary to examine a number of fibers oriented in the N-S position to find true α (α will be shown for the fibers that show the lowest RI).

13.6.5.10.2 When measuring γ (the higher RI) for anthophyllite, the fiber should be oriented in the parallel (E-W) position. Fibers of anthophyllite lying flat on the slide will always show γ and not γ', because the c-axis of the fiber will lie within the plane of the slide.

13.7 Quantification of Asbestos Content

13.7.1 General

13.7.1.1 Asbestos is reported as mass fraction percent for LA and is reported as area fraction percent for chrysotile, amosite, crocidolite, and anthophyllite.

13.7.1.2 Asbestos must be positively identified, and its optical properties measured and recorded, before asbestos can be reported in any quantity, including trace.

13.7.1.3 Quantification of asbestos concentration is performed by making a calibrated visual estimate by PLM on carefully prepared slide mounts of the sample material, in conjunction with stereomicroscopic examination of the sample.

13.7.2 Calibrated Visual Estimate of Asbestos Concentration by PLM

13.7.2.1 To perform a calibrated visual estimate, first decide on the best optical set-up to maximize the contrast between asbestos and non-asbestos phases within the slide mounts.

13.7.2.2 Higher magnifications (200X or 400X) will improve the visibility of asbestos when it is very fine. Lower magnification (100X) should be used when the asbestos is coarse. Use of the compensator plate under crossed polars enhances the contrast between asbestos and non-asbestos on some samples.

13.7.2.3 Scan the entire area of the slides, paying attention to the relative proportion of asbestos to non-asbestos.

13.7.2.4 Draw on previous experience to make a precise calibrated visual estimate. Making accurate calibrated visual estimates is a skill that must be learned and analysts generally improve over time.

13.7.3 Use of Reference Materials for Visual Estimation of Asbestos Content

13.7.3.1 Visual area estimation is a semi-quantitative approach requiring the microscopist to estimate the area fraction of asbestos as a percentage of the total material present over many fields of view. Area fraction estimation may be difficult, especially at low concentration values and because the desired output for LA is an estimate of mass fraction (percent asbestos by weight). As a result, all visual estimates of LA content will be performed using a set of site-specific reference materials (calibration standards) as a frame of reference. These Controlled PE Reference Materials will contain either 0.2% or 1.0% LA by weight[1] and were prepared for analysis using the same approach as for field samples.

13.7.3.2 Labs analyzing samples for LA should prepare five slide mounts each of the 0.2% and 1.0% Controlled PE Reference Materials in a permanent medium, such as epoxy or melt-mount. These permanently-mounted slides can then be readily referred to by analysts as needed. When using the 0.2% and 1.0% standards as calibration materials for visual estimates, always examine the entire area of all five slide preparations by PLM for each of these standards. This will guard against potential analytical bias that may be introduced by inhomogeneities in the calibration standards.

13.7.3.3 Photomicrographs of representative fields of view of the 0.2% and 1.0% LA reference materials are included as Attachment 7 of this SOP so that analysts may refer to them as needed.

13.7.3.4 Note that because these reference materials are based on LA, they are not appropriate for estimating the mass percent of other types of asbestos (chrysotile, amosite, crocidolite, or anthophyllite). Therefore, if any asbestos types besides LA are observed, the reported values for those asbestos types should be in units of area percent.

[1] The nominal mass fraction of the reference materials (calibration standards) is based on the gravimetric fraction of the material that is soil and the amount that is spiking material, adjusted for the fraction of the spiking material that is LA. For example, if the spiking material were estimated to contain 85% LA by mass, then the 1.0% calibration standard would contain 1.18 grams of spiking material (1.00 grams of LA) per 100 grams of calibration standard. Because the estimate of LA content of the spiking material is approximate, the true concentration of a calibration material may not be precisely equal to the nominal value.

13.7.3.5 It is recommended that laboratories prepare their own permanently-mounted slides of other asbestos types (such as amosite and chrysotile) in low concentrations. This can be performed by weighing out small quantities of relatively pure asbestos (such as NIST SRM's 1866b and 1867a) and a non-asbestos matrix material (such as calcite or gypsum). The two fractions can then be mixed together, and the mixture can be mounted on a slide in a permanent medium, such as epoxy or melt-mount.

13.7.3.6 Visual comparison charts can be posted on the walls of the PLM laboratory within sight of the microscope(s) so that analysts may refer to them as necessary. A number of these charts are available, such as the Comparison Chart for Visual Percentage Estimation (after Terry and Chilingar, 1955) and the visual estimation charts developed by Dr. Shu-Chun Su (see References).

13.7.3.7 For LA, compare what is seen in the 0.2% and 1.0% Controlled PE Reference Materials and visual comparison charts as needed. The concentrations of LA in the 0.2% and 1.0% reference materials were placed at the "bin cut-offs" that place LA concentrations of each sample into one of four categories (see Section 13.8.5, below).

13.7.3.8 Other LA reference materials, such as the 0.5% and 2.0% reference materials, may also be used for comparison when performing visual estimates. However, analysts should rely primarily on the 0.2% and 1.0% Controlled PE Reference Materials for assignment of samples to bin categories; the other reference materials should be used only as supporting tools for determining LA content.

13.7.4 Combining Stereomicroscopic and PLM Visual Estimates

13.7.4.1 Analysts must not place over-reliance on either stereomicroscopy or PLM when performing visual estimates. The advantage of stereomicroscopy is that the entire sample can be examined. However, once fibers are smaller than a certain size (approximately 250 µm or less in length) it becomes difficult to impossible to find them with the stereomicroscope and mount them in a RI liquid for positive identification by PLM. Conversely, only a small sub-sample of the whole sample is examined in the random slide mounts prepared for PLM analysis. This means a PLM result can be biased high or low if the prepared slides are not representative of the sample as a whole. Therefore, it is necessary to base a calibrated visual estimate of asbestos content on both detailed stereomicroscopic observation of the entire sample and examination of the entire area of all five prepared slide mounts by PLM, as both microscopic tools are complementary to one another.

13.7.4.2 Examine every sample stereomicroscopically to produce an initial estimate of asbestos content. As described in Section 13.2 of this SOP, this preliminary stereomicroscopic visual estimate of asbestos content is recorded on the analytical bench sheet.

13.7.4.3 Carefully analyze the entire area of all five prepared slide mounts of the sample by PLM. The PLM result is then compared to the original stereomicroscopic estimate of asbestos concentration. The PLM result will confirm, refine, or deny the original stereomicroscopic estimate.

13.7.4.4 The PLM result may indicate the need to re-examine the sample stereomicroscopically, and possibly, the need to re-mount and re-analyze the sample by PLM.

13.7.4.5 Decide what asbestos concentration to report based on both the stereomicroscopic estimation of asbestos content and the PLM visual estimate of asbestos content. Stereomicroscopic examination is often an iterative process used in conjunction with analysis by PLM. Refer to Attachment 8 for a flow diagram describing this entire process.

13.7.4.6 If the asbestos is fine, more weight should be placed on the PLM mounts when estimating asbestos content. If the asbestos is coarse, more weight should be placed on the stereomicroscopic estimate. However, both stereomicroscopic examination and PLM are required for every Libby soil sample analyzed at the laboratory.

13.7.4.7 If different asbestos concentrations are observed in the different slide mounts, then the PLM estimate should be an average of all prepared slides.

13.7.5 LA Bin Categories

13.7.5.1 All winchite, richterite, tremolite, actinolite, magnesio-arfvedsonite, and magnesio-riebeckite observed in a sample is counted as LA and contributes to the bin category (described in Table 13.2), regardless of its morphology type or aspect ratio. This includes prismatic LA, as well as more fibrous varieties, such as bundles with fibers crossing at various angles giving the bundle a “matted” appearance. Refer to Attachment 5 for examples of a wide range of LA morphologies. Also refer to Attachment 6 for photomicrographs of representative examples of LA morphologies as imaged by the United States Geological Survey (USGS) by Scanning Electron Microscopy (SEM).

13.7.5.2 Using the two Controlled PE Reference Materials (0.2% and 1.0%) as a visual guide, the microscopist will evaluate the sample and report LA results as follows:

Table 13.2

PLM Laboratory Report			Description
Qual	Conc (wt.%)	Bin	
ND		A	LA was not observed in the sample
Tr		B1	LA was observed in the sample at a level that appeared to be lower than the 0.2% reference material
<	1	B2	LA was observed in the sample at a level that appeared to be approximately equal to or greater than the 0.2% reference material but was less than the 1% reference material.
	1, 2, 3, etc	C	LA was observed in the sample at a level that appeared to equal or exceed the 1% reference material. In this case, the mass percent is estimated quantitatively.

13.7.5.3 **"ND" (not detected) in the Qualifier column** is used for all samples in which LA is not observed using stereomicroscopy and is also not detected in each of a minimum of five different PLM slides prepared using representative sub-samples of the test material. These samples are assigned to **Bin A**.

13.7.5.4 **"Tr" (trace) in the Qualifier column** is used for all samples in which LA is observed either using stereomicroscopy or in at least one of the five required PLM slides prepared from representative sub-samples of the test material, and in which the amount of LA present appears to be less than the 0.2% reference material. These samples are assigned to **Bin B1**.

13.7.5.5 **"<" (less than) in the Qualifier column and "1" in the Concentration column** is used for all samples in which LA is observed either by stereomicroscopy or by PLM in slides prepared from representative sub-samples of the test material, and in which the average amount of LA present appears to be equal to or greater than the 0.2% reference material but less than the 1% reference material. These samples are assigned to **Bin B2**.

13.7.5.6 **A numeric value (1, 2, 3, etc.) in the Concentration column without an entry in the Qualifier column** is used for all samples in which LA is observed either by stereomicroscopy or by PLM in slides prepared from representative sub-samples of the test material, and in which the average amount of LA present appears to be equal to or greater than the 1% reference material. These samples are assigned to **Bin C**.

13.7.6 Visual Estimations for Chrysotile, Amosite, Crocidolite, and Anthophyllite

13.7.6.1 Visual estimates for chrysotile, amosite, crocidolite, and anthophyllite are reported as area percent.

13.7.6.2 Do not use the bins designed for LA content for concentrations of chrysotile, amosite, crocidolite, and anthophyllite. Rather, report area fraction as ND if these analytes are not detected, "<1" if these analytes were detected but at a concentration of less than 1% by area, or to the nearest whole percentage (1%, 2%, 3%, etc.) if these analytes were detected at a concentration of 1% or higher.

13.8 Non-Asbestos Fibrous Constituents

13.8.1 When non-asbestos fibers are observed, measure and record on the bench sheet at least one optical property that distinguishes the fiber from asbestos.

13.8.2 There are several non-asbestos fibers that can be confused with asbestos, and the analyst must be aware of their properties and morphologies. Commonly encountered non-asbestos fibers are listed below.

13.8.3 Talc $Mg_3Si_4O_{10}(OH)_2$

13.8.3.1 Talc usually occurs in a platy or fibrous morphology that looks similar to that of chrysotile.

13.8.3.2 Talc has a higher birefringence than chrysotile.

13.8.3.3 The birefringence of talc is in the range of 0.03 to 0.05 which gives relatively fine fibers of talc first order white to yellow interference colors under crossed polars. Chrysotile fibers of comparable size would have low first order gray interference colors.

13.8.3.4 Talc has higher refractive indices (α = 1.54 to 1.56, γ = 1.57 to 1.60) than chrysotile.

13.8.3.5 Talc's refractive indices are less than those of tremolite, actinolite, or anthophyllite.

13.8.4 Wollastonite $CaSiO_3$

13.8.4.1 Wollastonite is one of the pyroxenoid minerals and has a characteristically bladed or prismatic morphology.

13.8.4.2 Wollastonite is colorless in plane light.

13.8.4.3 The refractive indices of wollastonite are very close to that of tremolite. However, wollastonite has a lower birefringence (difference between α and γ = 0.013 to 0.017) than tremolite.

13.8.4.4 Wollastonite has an extinction angle of up to approximately five degrees, which makes it easy to confuse with tremolite.

13.8.4.5 Crystals of wollastonite can be spun about their long axis until they change from length slow to length fast or vice versa. Crystals of tremolite will always remain consistently length slow regardless of their optical orientation.

13.8.4.6 One way to spin a wollastonite grain about its long axis is to agitate the mixture of RI liquid and sample material by repeatedly tapping the cover slip with the point of a ball point pen. Unless the crystals are lying flat on one crystal face, they should rotate as the RI liquid is agitated.

13.8.5 Kyanite Al_2SiO_5

13.8.5.1 Kyanite is an orthosilicate mineral that is commonly used in refractory materials.

13.8.5.2 Kyanite usually has a bladed or columnar morphology.

13.8.5.3 Kyanite is colorless to light blue in plane light. Its blue color is much more subdued than that of crocidolite.

13.8.5.4 Kyanite has positive relief in 1.680 oil. Its refractive indices are higher than those of crocidolite or amosite (for kyanite, α = 1.710 to 1.718, γ = 1.724 to 1.734).

13.8.6 Hornblende $(Ca,Na)_{2\text{-}3}(Mg,Fe,Al)_5Si_6(Si,Al)_2O_{22}(OH)_2$

13.8.6.1 Hornblende is one of the most common amphiboles, often found in soils in areas where certain types of igneous and metamorphic rocks are found. Hornblende is often found in soil samples from the Libby area.

13.8.6.2 Edenite, $NaCa_2(Mg,Fe^{2+})_5Si_7AlO_{22}(OH)_2$, is an amphibole that may be present at the mine at Libby (Meeker et al. 2003). Edenite is part of the hornblende group, and for this reason, for the purposes of this SOP, should not be classified as LA if it is encountered in a field sample.

13.8.6.3 Hornblende generally has slender prismatic to bladed crystals. The traces of cleavage planes are usually visible within of the crystals.

13.8.6.4 Hornblende does not occur in a highly fibrous morphology like LA often does.

13.8.6.5 Hornblende is distinctly colored and pleochroic. Hornblende is usually green, yellow-green, brown, green-brown, or blue-green in plane light.

13.8.6.6 Refractive indices vary with composition, but usually α = 1.645 to 1.665 and γ = 1.660 to 1.690. This is higher than LA.

13.8.6.7 Birefringence is moderate.

13.8.6.8 Hornblende can have parallel or inclined extinction depending on optical orientation. When extinction is inclined, the extinction angle is usually 14 to 25 degrees.

13.8.7 Calcic Clinopyroxene

13.8.7.1 The calcic clinopyroxene group includes Augite, $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$, and the end members Diopside, $CaMgSi_2O_6$, and Hedenbergite, $CaFeSi_2O_6$. These are mentioned here because they are among the most common pyroxenes, but analysts should be aware that there are others.

13.8.7.2 Calcic clinopyroxene can be found in soils from areas where certain types of igneous and metamorphic rocks occur and has been found in field samples from the Libby area.

13.8.7.3 The morphology of calcic clinopyroxene is usually prismatic to columnar. As a group, the pyroxenes tend to form less slender, elongated crystals than the amphiboles. Traces of cleavage planes are usually visible within crystals of the pyroxenes.

13.8.7.4 Augite is colorless, pale green, greenish-brown, pale brown, or gray in plane light. Diopside is colorless, but as iron content increases through the diopside-hedenbergite, the mineral develops a green color.

13.8.7.5 Calcic clinopyroxene can be weakly pleochroic.

13.8.7.6 Calcic clinopyroxene has high refractive indices (α = 1.66 to 1.75, γ = 1.69 to 1.77). The pyroxenes as a group tend to have high refractive indices.

13.8.7.7 Birefringence is moderate, as with the majority of other pyroxenes.

13.8.7.8 Calcic clinopyroxene can have a very high extinction angle, up to 48 degrees.

13.8.7.9 Calcic clinopyroxene is generally length slow, but the sign of elongation becomes ambiguous in crystals showing a very high extinction angle.

13.8.8 Fiberglass (Amorphous Silica, SiO_2)

13.8.8.1 Fiberglass is almost always isotropic (appears black at all orientations under crossed polars).

13.8.8.2 Some fiberglass that is coated with other materials, or fiberglass that has been de-vitrified (partial re-crystallization of amorphous silica) due to prolonged exposure to very high temperatures, may show some slight interference colors under crossed polars.

13.8.8.3 The morphology of fiberglass is usually straight, solid, cylindrical tubes. Usually the diameter of the tube varies little along the length of the fiber.

13.8.8.4 Most fiberglass is colorless under plane light. However, the addition of impurities can impart various colors to fiberglass. Some can be yellow, dark brown, or dark green.

13.8.8.5 The RI of fiberglass varies considerably depending on the glass's composition (i.e. the addition of impurities, such as aluminum or iron). However, the RI of most types of fiberglass is close to 1.6.

13.8.9 Cellulose

13.8.9.1 Cellulose often has the morphology of ribbons that are wider than they are thick. The interiors of cellulose fibers often show a cellular or structured network.

13.8.9.2 Cellulose can be straight, curved, kinked, or crooked.

13.8.9.3 Cellulose is usually colorless under plane light, although it can be yellow, tan, or brown. Sometimes it has been dyed to various colors, such as red, blue, green, etc.

13.8.9.4 Cellulose displays undulatory (incomplete) extinction.

13.8.9.5 Cellulose usually has a higher birefringence than chrysotile.

13.8.9.6 Fibers of cellulose will often show first order white or yellow or higher interference colors under crossed polars.

13.8.10 Diatoms

13.8.10.1 Diatoms are minute organisms that live in both salt and freshwater and secrete shells of amorphous silica. When they die, their shells accumulate to form what is called diatomaceous earth. This diatomaceous earth is mined and is used in a variety of construction materials.

13.8.10.2 Not all diatoms are fibrous, but many are.

13.8.10.3 Fibrous diatoms generally have the morphology of cylindrical tubes, sometimes with tapered ends.

13.8.10.4 When fibrous diatoms are found in a sample, other diatoms having circular or other various (elliptical, lenticular, etc.) shapes are often found in the same sample.

13.8.10.5 Many diatom shells have complex internal structure.

13.8.10.6 Because they are made of amorphous silica, diatoms as a rule are isotropic. However, extreme heating or diagenetic processes can lead to de-vitrification, causing some diatoms to become weakly birefringent as a result.

13.8.11 Hair

13.8.11.1 Hair is usually cylindrical in shape; many fibers of hair are tapered.

13.8.11.2 Hair is usually colorless, tan, brown, or red-brown in plane light.

13.8.11.3 A central canal is often visible in hair fibers.

13.8.12 Synthetic Fibers

13.8.12.1 Synthetic fibers can be any color, including clear, pink, red, purple, blue, green, yellow, etc.

13.8.12.2 Synthetic fibers typically lack the splayed ends that chrysotile bundles commonly exhibit. Many synthetic fibers display a cylindrical morphology.

13.8.12.3 Synthetic fibers almost always have high to very high birefringence (0.1 or higher).

13.8.12.4 Many synthetic fibers show parallel extinction.

13.8.12.5 The synthetic fiber polyethylene has a wispy habit very similar to that of chrysotile.

13.8.12.6 Polyethylene has a higher birefringence than chrysotile.

13.8.12.7 Polyethylene fibers will melt if the slide is placed on the hot plate whereas chrysotile will not.

13.8.13 Rutile (TiO_2)

13.8.13.1 Titanium oxide occurs naturally as the mineral rutile, TiO_2. Rutile generally occurs as small prisms or fine acicular needles.

13.8.13.2 Refractive indices are extremely high (α = 2.6 to 2.7, γ = 2.8 to 2.9).
13.8.13.3 Rutile can be gray, brown, reddish-brown, or nearly opaque.
13.8.13.4 Needles of rutile have high birefringence, are length slow, and show parallel extinction.
13.8.13.5 Rutile occurs as an accessory mineral in certain types of igneous rocks, and because of its durability and resistance to weathering, it can sometimes be found as very small loose needles in soils. Rutile can sometimes be seen as needles that are inclusions in quartz crystals and are referred to as rutilated quartz.

14.0 RECORDING DATA AND RESULTS

14.1 Data Recording Sheets

14.1.1 Analysts record, by hand, on analytical data recording sheets (bench sheets), analytical results at the time the observations are made. Refer to Attachment 1 for a PLM-VE data recording sheet.
14.1.1.1 Additional bench sheets may be created by the laboratory as long as all of the required fields are included.
14.1.2 Completed bench sheets are the original, hard-copy records on which test data on client samples is stored.

14.2 Stereomicroscopic Examination Reportables

14.2.1 Homogeneity (Yes or No)
14.2.2 Sample appearance, including color and texture
14.2.3 Estimated percent LA
14.2.4 Estimated percent other asbestos (other amphibole and chrysotile)

14.3 Reporting Positive Asbestos Results

14.3.1 If asbestos is positively identified in the sample, record the following data for each asbestos type that is present in the sample.
14.3.2 Morphology
14.3.3 Fiber color
14.3.4 Pleochroism (Yes or No)
14.3.5 Indices of refraction (α and γ)
14.3.6 Birefringence
14.3.6.1 Low if birefringence is less than 0.010; medium if birefringence is 0.010 to 0.050; high if birefringence is greater than 0.050.
14.3.7 Extinction characteristics
14.3.7.1 Parallel or oblique/inclined
14.3.8 Sign of elongation (positive or negative)
14.3.9 Qualifier and percentages of the following materials in the sample
14.3.9.1 LA
14.3.9.2 Other amphibole (amosite, anthophyllite, or crocidolite)
14.3.9.3 Chrysotile
14.3.10 Bin assignment for LA (see Section 13.7.5)

14.4 Other Reportables

- 14.4.1 Record the percent non-asbestos fibrous materials, such as fibrous glass, cellulose, synthetic fibers, etc.
  - 14.4.1.1 Record at least one optical property that identifies the material as a non-asbestos fiber (see Section 13.8).
- 14.4.2 Record the identity of the matrix material(s), if known.
- 14.4.3 Record if there was any deviation from the SOP or the analytical method.
- 14.4.4 Record the QA type as Not QA, Laboratory Duplicate – Self-check (LDS), or Laboratory Duplicate – Cross-check (LDC).
- 14.4.5 Record any pertinent comments.
- 14.4.6 Sign or initial the bench sheet, and record the date of analysis.

15.0 DATA REPORTING

15.1 EDD Report Generation

- 15.1.1 Results of PLM analyses are provided to the client in an EDD.
- 15.1.2 All of the data recorded on the bench sheet is entered into an EDD in the form of an Excel spreadsheet.
  - 15.1.2.1 The EDD was developed specifically for the Libby project, and the laboratory should check with the client to be sure it is using the most recent version of the spreadsheet.
  - 15.1.2.2 Only one EDD is produced for each work order number.
  - 15.1.2.3 Data entry instructions are provided on the spreadsheet.
- 15.1.3 After entering all data into the EDD, save the file by clicking on the macro button located on “Visual_data entry” worksheet.
  - 15.1.3.1 The file name is generated automatically by concatenating Information entered on the “General_data entry” worksheet.
  - 15.1.3.2 The information used to create the file name is the laboratory name, work order number, and analysis type (visual estimation).
- 15.1.4 The directory where the macro will save the file depends on how the template spreadsheet was opened.
  - 15.1.4.1 Be sure there is a blank spreadsheet template in each folder where EDD’s will be saved.
  - 15.1.4.2 If Excel is opened, and then the blank template spreadsheet is opened, the file will be saved in the same directory where the original blank template spreadsheet was opened from.
  - 15.1.4.3 Do not open the blank template spreadsheet from Windows Explorer, because then the file will be saved at the computer’s default directory for Excel (generally, this default directory is C:\Documents and Settings\My Documents).
- 15.1.5 The EDD serves as an electronic version of the test report submitted to the client.
  - 15.1.5.1 A hard copy of the test report is also mailed or couriered to the client following delivery of the EDD (see Section 15.3 for further details about hardcopy data reports).
  - 15.1.5.2 The laboratory retains all original records for use in resolving any questions until otherwise instructed by EPA.

15.2 Data Package Generation

15.2.1 Hardcopy reports of the raw analytical data are submitted to EPA, or their project oversight contractors, for archival.

15.2.2 A completed data package consists of a cover sheet signed and initialed by approved signatories and the following documentation:

15.2.2.1 Number of samples received, and copies of the signed chains of custody.

15.2.2.2 The date of sample receipt and condition of samples.

15.2.2.3 The Case Narrative, including any opinions and interpretations; deviations, modifications, additions to, or exclusions from the test method; descriptions of any problems encountered in the analysis; or any specific conditions that could affect the results. Also include the following disclaimer: "This test report relates only to items tested."

15.2.2.4 Verification that microscope slides were wiped clean before use.

15.2.2.5 Calibration data for the RI liquids used in the analysis.

15.2.2.6 Verification that the microscope was properly calibrated before use.

15.2.2.7 Verification that reference materials were used for comparison when performing calibrated visual estimates of asbestos content.

15.2.2.8 Visual Estimate hard copy data forms, as presented in the EDD and containing the analytical data (including all cross-check and self-check QC's performed on any samples in the work order number).

15.2.2.9 Copies of the handwritten bench sheets containing the analyst's original data and observations.

15.2.3 Refer to Attachment 3, the Data Package Checklist, for a complete list of items required for each data package.

15.2.4 Each test report is identified by a unique Laboratory Information Management System (LIMS) number called a Work Order Number, Job Number, or equivalent.

15.2.5 When opinions and interpretations are provided in a test report, the laboratory will:

15.2.5.1 Document the basis on which the opinions and interpretations were made.

15.2.5.2 Clearly indicate on the test report which items are opinions and interpretations.

15.2.6 Once the data package is complete, all pages must be paginated prior to delivery to the client.

15.3 Delivery of Results to Client

15.3.1 The following items will be submitted electronically (via e-mail) to the client:

15.3.1.1 The completed EDD containing the analytical data. This spreadsheet is presented in a format that can be imported into the EPA's data management software.

15.3.1.2 A scanned .pdf of all items in the data package described above, including the cover sheet signed by an approved signatory, the signed chains of custody, and the analyst's original bench sheets. All signatures must be originals, or if electronic signatures are used, the e-signature must be controlled by a password-protected login that allows its application only by the signer.

15.3.1.3 The two above files are e-mailed to the client, including all parties on the distribution list submitted by the client to the laboratory.

15.3.2 Once the results of a work order number have been delivered to the client, a hardcopy of the data package is sent to the client through the mail.

16.0 QUALITY ASSURANCE AND QUALITY CONTROL

16.1 General

16.1.1 The laboratory operates under a quality system appropriate to the type, range, and volume of testing work that it performs.

16.1.2 Results of QC analyses are used to track the precision and accuracy of the laboratory's analyses, and to identify areas that require or could benefit from improvement.

16.1.3 The following types of QC analyses are performed on a scheduled basis at the laboratory:

16.1.3.1 Re-analysis of client samples by the same analyst (self-check analysis) or by a different analyst (cross-check analysis).

16.1.3.2 Repeated analyses on calibration standards of known asbestos concentration.

16.1.3.3 NIST proficiency testing.

16.1.3.4 Inter-laboratory analyses.

16.1.4 Records are kept of all QA documentation.

16.1.5 All QC analyses must be performed in real-time.

16.2 Calibration Standards

16.2.1 Visual estimates of asbestos concentrations are calibrated with the use of the calibration standards.

16.2.2 The calibration standards are a set of permanently mounted slides of known asbestos concentrations. They should cover a wide range of asbestos concentrations.

16.2.3 Reference materials used to prepare calibration standards are NIST SRM's 1866b and 1867a, Controlled PE Reference Materials, and samples from past NIST proficiency testing rounds.

16.2.3.1 Controlled PE Reference Materials at concentrations of 0.2% and 1.0% LA in soils are required to delineate between the bin assignments; however, those concentrations, as well as concentrations of 0.5% and 2.0%, are useful for the calibration of visual area estimates for low end samples.

16.2.3.2 "Working standard" refers to any calibration standard that was prepared internally at the laboratory. Laboratories are encouraged to prepare these standards over a range of asbestos concentrations. These slides should not just be prepared of Libby Amphibole but for other asbestos types as well.

16.3 Use of Calibration Standards for Precision and Accuracy Testing

16.3.1 The best way to track analyst precision and accuracy is by the analysis of standards of known asbestos concentration.

16.3.1.1 All analysts need to analyze calibration standards on a regular basis.

16.3.1.2 Regular analysis of the calibration standards provides a routine check of analyst precision and accuracy.

16.3.1.3 Calibration standards are read at a frequency on one per 100 client samples.

16.3.2 Vary the calibration standards read each month so that analysts are constantly presented with standards of different asbestos concentrations, various asbestos types, and various matrix material types.

16.3.3 The analysts must be blind to the known values of the calibration standards.

16.3.4 The Laboratory Manager, QA/QC Coordinator, or designate other than the analyst performing the test, will review the results for acceptability.

16.3.5 After completion of analyses of calibration standards, analysts are advised of the reference values of the standards so they can see how they performed and calibrate their readings on client samples accordingly. For example, the reported value of blind calibration standards below 1% should fall in the correct concentration bin.

16.3.6 Repeated analysis of the calibration standards provides a benchmark upon which analysts may base their visual estimations of percentage levels of asbestos in client samples. Use of control charts for concentrations 1% or greater is recommended.

16.3.7 Corrective action(s) must be taken immediately if calibration standards do not meet acceptance criteria. Examples of corrective actions that may be taken are re-analysis of calibration standards, re-preparation of calibration standards, and analyst re-training.

16.3.8 Analyses of the calibration standards are not reported as part of an EDD or data package. Rather, laboratories are responsible for maintaining an internal system for tracking analyses of these calibration standards.

16.4 Self-Check and Cross-Check QC Analyses (Duplicates and Replicates)

16.4.1 For each set of samples, 10% of the samples must be re-analyzed within the laboratory.

16.4.2 A QC analysis (self-check or cross-check) can be performed on any sample.

16.4.2.1 QC analyses need to be performed on samples over the entire range of asbestos concentrations that are encountered in site samples.

16.4.2.2 Any sample that is considered especially unusual or difficult should be re-analyzed for QC purposes.

16.4.3 The frequency of self-check QC analyses on client samples will be 1 per 50 samples analyzed (2%). Self-check analyses should be performed as a remount of the sample (see Section 13.3 for slide preparation procedures).

16.4.4 The frequency of cross-check QC analyses on client samples will be 8 per 100 samples analyzed (8%). Cross-check analyses should be done on the five original slide preparations.

16.4.4.1 All analysts performing QC analyses must be experienced with PLM analysis of soil samples from the Libby Asbestos Superfund Site and the specific requirements of this SOP.

16.4.4.2 If there is only one primary analyst at the laboratory performing PLM analysis on these samples, the laboratory must send all cross-check QC samples to another Libby laboratory with the proper experience and qualifications.

16.4.5 The self-check and cross-check analysis is acceptable if results are within a bin category (i.e., ± 1 bin) for reported concentrations below 1% LA. For all asbestos types greater than 1%, it is recommended that precision is tracked using control charting or a similar tool.

16.4.6 Corrective action(s) must be taken immediately if re-analyses do not meet acceptance criteria. Examples of corrective actions that may be taken are re-analysis and/or re-preparation and re-analysis of original and duplicate or replicate samples, analyst re-training, and notification to EPA, or their designate.

16.4.7 When performing a QC analysis, it is necessary to mark LDS or LDC in the “QA Type” section of the bench sheet.

16.5 Inter-Laboratory Analyses

16.5.1 The laboratory is involved in an ongoing sample exchange program with other PLM laboratories that analyze soil samples from the Libby Asbestos Superfund Site. The purpose of this program is to help detect and minimize laboratory biases and characterize precision across laboratories performing PLM-VE testing.

16.5.2 The frequency of the inter-laboratory sample exchange ranges from 1 in 100 samples analyzed exchanged amongst laboratories on a quarterly basis. However, higher frequencies of inter-laboratory sample analysis are required when a laboratory is new to the program, when systematic errors or biases are observed, or when a new version of the SOP is distributed. Whether or not the frequency to be performed is the minimum or higher is determined by EPA or their designate.

16.5.3 Results of the inter-laboratory analyses are reviewed by EPA, or their designate.

16.5.4 The inter-laboratory analysis is acceptable if results are within a bin category (i.e., ± 1 bin) for reported concentrations below 1% LA.

16.5.5 Corrective action(s) must be taken immediately if analyses do not meet acceptance criteria. The specific course of action based on these results will be determined by EPA, or their designate. Common actions include re-analysis and/or re-preparation and re-analysis of original and duplicate or replicate samples, collaboration between and amongst laboratories performing the test to root out biases, and analyst re-training.

17.0 REFERENCES

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18.4 Deer, W.A., Howie, R.A., and Zussman, J. (1997). Rock Forming Minerals Volume 2B: Double Chain Silicates. 2nd Edition. The Geological Society, London.

18.5 EPA Method 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials. (July 1993).

18.6 Federal Register, 40 CFR Part 763, Volume 52, No 210, “Asbestos Containing Materials in Schools; Final Rule and Notice.”

18.7 McCrone Research Institute (1987). Dispersion Staining Color Chart.

18.8 Meeker, G.P., Bern, A.M., Brownfield, I.K., Lowers, H.A., Sutley, S.J., Hoefen, T.M., and Vance, J.S. (2003). The Composition and Morphology of Amphiboles from the Rainy Creek Complex Near Libby Montana. American Mineralogist, 88, 1955-1969.

18.9 NIOSH Method 9002: Asbestos (bulk) by PLM. Manual of Analytical Methods, 4th Edition. (August 1994).

18.10 NIST Handbook 150, 2006 Edition, "NVLAP Procedures and General Requirements."

18.11 State of California Air Resources Board Method 435: Determination of Asbestos Content of Serpentine Aggregate. (June 1991).

18.12 Su, Shu-Chun (2004). Area Percentage Charts With Matrix and Area Percentage Charts With No Matrix.

18.13 Su, Shu-Chun (1996). Rapidly and Accurately Determining Refractive Indices of Asbestos Fibers by Using Dispersion Staining Method.

18.14 Terry and Chilingar (1955). Comparison Chart for Visual Percentage Estimation.

18.15 William D. Nesse (1991). Introduction to Optical Mineral Mineralogy. New York: Oxford University Press.

18.16 Wylie, A.G. and Verkouteren, J.R. (2000). Amphibole asbestos from Libby, Montana: Aspects of nomenclature. American Mineralogist, 85, 1540-1542.

19.0 LIST OF ATTACHMENTS

19.1 Attachment 1: PLM-VE Data Recording Sheet

19.2 Attachment 2: RI Liquid Calibration Conversion Tables

19.3 Attachment 3: Data Package Checklist from PLM Data Sheet and EDD

19.4 Attachment 4: Optical Properties of Fibrous Amphiboles

19.5 Attachment 5: PLM Photomicrographs Demonstrating a Wide Range of Libby Amphibole Morphologies

19.6 Attachment 6: SEM Photomicrographs of Representative Examples of Libby Amphibole Morphologies

19.7 Attachment 7: Photomicrographs of Representative Fields of View of 0.2% and 1.0% Libby Amphibole Controlled PE Reference Materials

19.8 Attachment 8: Flow Diagram for Determining LA Content by Complementary Use of Stereomicroscopic Examination and PLM Visual Estimation

ATTACHMENT 1

PLM-VE Data Recording Sheet

PLM VISUAL ESTIMATION DATA RECORDING SHEET

Laboratory Name ______________________________ Date Received ____________

Job Number ______________________________ SOP Name/Revision ______________________

Note: Data Recording Sheet is formatted to print on 11x17 paper.

EPA Index ID	Index Suffix Char.	Index Suffix No.	QA Type (NOT QA, LDS, LDC)	Lab Sample ID	Date Analyzed	Analyst Name	**Stereomicroscopy Examination**					**Libby Amphibole**		**Other Amphibole**			**Chrysotile**		Deviation?	Comments (list below)	**OPTICAL PROPERTIES FOR LA (see key for appropriate data inputs)**							
							Sample Appearance	Est. % LA		Est. % OA and C																		
								Qual (ND, Tr, <)	Mass Fract (%)	Qual (ND, <)	Area Fract (%)	Qual (ND, Tr, <)	Mass Fract (%)	Qual (ND, <)	Area Fract (%)	OA Type (AMOS, ANTH, CROC, UNK)	Qual (ND, <)	Area Fract (%)			Morph.	Fiber Color	Sign Elong. (+/)	Pleoch. (Y/N)	Angle Extinct.	Ref. Index α	Ref. Index γ	Biref.

Comments (Use back if needed)

ATTACHMENT 2

RI Liquid Calibration Conversion Tables

Prepared by Dr. Shu-Chun Su, Hercules, Inc.

See attached Excel spreadsheet entitled

“Create_RI_Liquid_Calibration_Conversion_Tables.xls”

ATTACHMENT 3

Data Package Checklist

From PLM (VE and PC) Data Sheet and EDD.xls

STANDARD LABORATORY DATA PACKAGE CHECKLIST
Analytical Test Report
Bulk Asbestos Analysis by Polarized Light Microscopy (PLM)

Prepared For: ______________________

City/State: ______________________

Laboratory Name: ______________________

City/State: ______________________

Laboratory Job No.: ______________________

Method Utilized (SOP and Rev. No.): SRC-LIBBY-03/Revision 2

Circle One: Visual Estimation   Point Counting Approach

Report Reviewed by: ______________________

STANDARD LABORATORY DATA PACKAGE CHECKLIST

Instructions:	**For PLM analytical results raw data packages, complete and sign the following checklist. Attach supporting documentation as outlined below. Organize the supporting documentation in the order listed below. Paginate the completed raw data package.**	**Laboratory Verification (Initials and Date)**	**Validator Verification (Initials and Date)**
1	<u>Number of samples received:</u>______________ *An SDG is defined as no more than 200 samples.* **Additional Supporting Documentation:** Attach COC forms having footer R (report).		
2	<u>Date of sample receipt and condition of samples:</u>______________ *For Condition of samples enter "OK" or "See SDG Case Narrative".*		
3	<u>SDG Case Narrative</u>: **Additional Supporting Documentation:** Attach SDG Narrative and any modification forms.		
4	<u>Check for contamination (daily)</u>: Wipe microscope slides with lens paper before using. *Laboratory Verification initial and date signifies that this has been performed for the samples in this SDG.*		
5	<u>Verification of the refractive indices of the refractive index liquids once per month</u>: **Additional Supporting Documentation:** Provide information indicating a <u>monthly</u> record of checking each of the four liquids including liquid name, lot number and analyst initials. (See table - Results of RI Liquids Calibration)		
6	<u>Verification of microscope adjustments prior to each SDG</u>: *Laboratory Verification initial and date signifies that this has been performed for the samples in this SDG.*		
7	<u>Reference material - Visual Estimation Approach</u>: *Laboratory Verification initial and date signifies that this has been performed for the samples in this SDG.*		
	<u>Reference material - Point Counting Approach</u>: **Additional Supporting Documentation:** Provide calibration curve documentation, printed from the EDD spreadsheet.		
8	<u>VE and/or PC hard copy data forms (as presented in the EDD spreadsheet)</u>: **Additional Supporting Documentation:** Copies of the Hard Copy Data Forms for all investigative samples and laboratory duplicates will be provided from systems that are entered electronically.		
9	<u>Bench sheets for data results</u>: **Additional Supporting Documentation**: Provide copies of the hand written or LIMS system generated raw data sheets for sample results.		

COCs

SDG NARRATIVE

Instructions: The following information should be included in all narratives. Please see the attached narrative template.

1 List the method or methods used.
2 For any modifications, reference the modification number and attach a copy of the signed document to the raw data
3 If sample condition is not "OK", explain why and any implications to the data.

SDG NARRATIVE EXAMPLE

SDG Narrative - PLM Analysis by SRC-LIBBY-03 Revision 2

Laboratory Job Number:_______________

The samples were received in sealed coolers [or other container]. [Any special notations about the samples as received goes here such as damaged in shipping, missing sample, etc.] The sample set was assigned a laboratory job number, each sample was assigned a unique, sequential laboratory ID number, and the job was entered into the Laboratory Information System. The laboratory ID numbers, shipping information and signatures were recorded on the CDM Chain of Custody and the login information was summarized on the laboratory Chain of Custody.

Samples were analyzed in accord with SRC-LIBBY-03 Rev. 2 [with modifications described on Laboratory Modification document(s): LB-___________ (see attached)].

SAMPLE RESULTS

See Attached Sample Results

Instructions: These sample result forms are from the current version of the PLM (VE & PC) Data Sheet and EDD.xls file. They are labeled in this file as the VE or PC hard copy data form.

BENCH SHEETS

Instructions: Please provide handwritten or LIMS system generated raw data sheets for sample results.

REFRACTIVE INDEX LIQUIDS

Instructions: Please see and follow attached table from Shu-Chun Su, Technical Expert for NVLAP Asbestos Programs. (Suggested Format for Recording Results of RI Liquids Calibration using Cargille Glass Standard and Dispersion Staining Method - Version: February 1996)

The following components are included in the table:

1 Date

2 Nominal or Labeled n_D 25 degree Celsius

3 Cargille Glass

3a Nominal or Labeled R.I.

3b Lot No.

4 Central Stop DS Observation

4a Predominant DS Color

4b Corresponding $alpha_0$

5 Liquid or Room Temperature (degree Celsius)

6 Actual or Calibrated n_D 25 degree Celsius

7 Difference between Calibrated n_D 25 degree Celsius and Labeled n_D 25 degree Celsius

8 Accept or Reject

9 Analyst

RESULTS OF RI LIQUIDS CALIBRATION

	RI Liquid[2]	Cargille Glass		CSDS Color of Glass4		Liquid or Room	Calibrated RI	Absolute Difference Between		
Date[1]	Labeled RI $(nD25°C)_{lbl}$	Labeled RI[3]	Lot No.[4]	Predominant CSDS Color[5]	Corresponding λ_0 (nm)[6]	Temperature (°C)[7]	of Liquid $(n_D^{25°C})_{clb}$ [8]	Calibrated and labeled RI $(n_D^{25°C})_{clb} - (n_D^{25°C})_{lbl}$ [9]	Accept or Reject[10]	Initials of Analyst[11]
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	
									A R	

1. Date: 2. The $n_D^{25°C}$ on the label of RI liquid bottle or $(n_D^{25°C})_{lbl}$; 3. The RI value on the label of Cargille calibrated glass vial; 4. The Lot No. on the label of Cargille calibrated glass vial; 5. The predominant central stop dispersion color displayed by glass fragments (do not be confused by the false CSDS color due to edge effect (see p.3). 6. The matching wavelength, λ_0, corresponding to the CSDS color in Column 5; 7. The temperature of the RI liquid or the room if the liquid's temperature can be considered to be in equilibrium with the room atmosphere; 8. The reading based on the values in Columns 6 and 7 from the conversion table for the liquid-glass combination. This value is the actual or calibrated RI of the liquid at 589 nm and 25 °C or $(n_D^{25°C})_{clb}$; 9. Column 8 minus Column 2; 10. If the *absolute* value of Column 9 is less or equal to 0.004, circle A for *acceptable*. Otherwise, circle R for *rejected*. 11. Analyst's initials.

$(nD25°C)_{lbl} = n_D^t + (25 - t)\, dn/dt$ (The temperature correction is built in the conversion tables.)

Version: December 1998 (Shu-Chun Su, Technical Expert for NVLAP Asbestos Programs)

ATTACHMENT 4

Optical Properties of Fibrous Amphiboles

OPTICAL PROPERTIES OF FIBROUS AMPHIBOLES ASSOCIATED WITH LIBBY AMPHIBOLE[A]

Libby Amphibole asbestos (LA) is a term used to categorize a group of minerals generally described as sodic tremolite. The solid solution series of sodic tremolite is comprised of a group of minerals, such as tremolite, actinolite, winchite, richterite, magnesio-riebeckite, and magnesio-arfvedsonite. The optical properties for each individual mineral are provided below. As seen, there is a great deal of overlap in optical properties among the minerals that make up LA. As such, discreet mineral identification is not required under this SOP. Rather, if the sample exhibits the optical properties of a mineral listed below, the specific optical properties (refractive indices, birefringence, extinction angle, and elongation sign) shall be noted on the analytical data sheet and electronic file, and the mineral identified as LA.

Mineral	Morphology and Color	Refractive Indices		Birefringence	Extinction	Elongation Sign
		α	γ			
Tremolite[7]	Straight to curved fibers and bundles. Colorless to pale green.	1.600-1.628 1.604-1.612 1.599-1.612 1.6063	1.625-1.655 1.627-1.635 1.625-1.637 1.6343	0.017-0.028	Oblique (up to 21 °);	+ (length slow)
Actinolite[7]		1.600-1.628 1.612-1.668 1.613-1.628 1.6126	1.625-1.655 1.635-1.688 1.638-1.655 1.6393	0.017-0.028		+ (length slow)
Winchite	Straight to curved fibers or bundles. Colorless to pale blue Pleochroism weak to moderate: X-colorless, Y=light blue-violet, Z=light blue[3]	**1.618-1.626**[1] **1.618-1.621**[2] 1.629[3] 1.636[4]	**1.634-1.642**[1] **1.634-1.637**[2] 1.650[3] 1.658[4]	**0.008-0.019**[1] **0.016**[2] 0.021[3] 0.022[4]	Oblique, **22°**[1] **15.8°**[2] Oblique, 7-29°[8]	+ (length slow)
Richterite	Straight to curved fibers or bundles. Colorless, pale yellow, brown, pale to dark green, or violet[8] Pleochroism weak to strong in pale yellow, orange, and red[5]	**1.622-1.623**[1] 1.605-1.624[5] 1.615[6]	**1.638-1.639**[1] 1.627-1.641[5] 1.636[6]	**0.012-0.017**[1] 0.017-0.022[5]	Oblique, **21-22°**[1] Oblique, 5-45°[8]	+ (length slow)
Magnesio-riebeckite	Prismatic to fibrous aggregates. Blue, grey-blue, pale blue to yellow. Can be pleochroic.[8]	1.650-1.673[8]	1.662-1.676[8]	Up to 0.015[8]	Oblique, 8-40°[8]	- (length fast) [8]
Magnesio-arfvedsonite	Prismatic to fibrous aggregates. Yellowish green, brownish green, or grey-blue. Can be pleochroic. [8]	1.623-1.660[8]	1.635-1.680[8]	0.012-0.026[8]	Oblique, 18-45°[8]	- (length fast) [8]

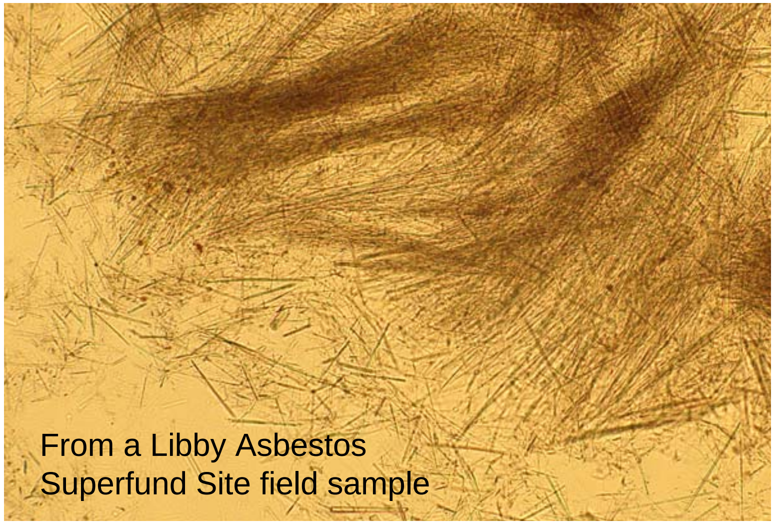
A. This table is adapted for use in the SOP from: Su, Shu-Chun, 2005. White paper: *Tables to Facilitate the Determination of Refractive Indices of Winchite and Richterite, (Libby, Montana) by Dispersion Staining*, **August 8, 2005** Data on this table were compiled from data of amphiboles from Libby, Montana and other localities. The data in **bold** are samples from Libby, Montana. The data of tremolite/actinolite are adapted from Table 2-2 of EPA/600/R-93/116.

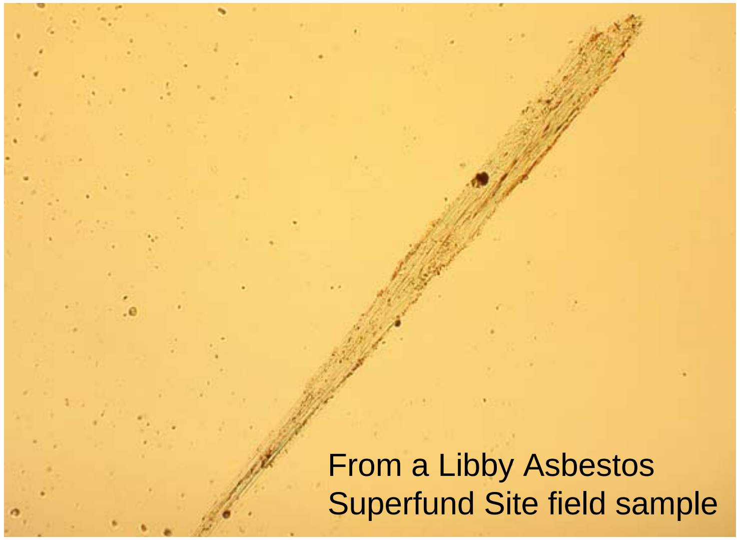
1. Bandli, B.R. et al. (2003) *Optical, compositional, morphological, and X-ray data on eleven particles of amphibole from Libby, Montana, U.S.A.* Canadian Mineralogist, 41, 1241-1253.
2. Wylie, A.G. and Verkouteren, J.R. (2000) *Amphibole asbestos from Libby, Montana: Aspects of nomenclature.* American Mineralogist, 85, 1540-1542.
3. www.minsocam.oeg/msa/Handbook/Winchite.PDF.
4. www.mindat.org/min-4296.html.
5. www.minsocam.oeg/msa/Handbook/Richterite.PDF.
6. www.webmineral.com/data/Richterite.shtml.
7. Adapted from: USEPA 1993. *Method for the Determination of Asbestos in Bulk Building Materials*. July 1993. (NTIS / PB93-218576).
8. W. A. Deer, R. A. Howie, and J. Zussman (1997). *Rock Forming Minerals Volume 2B: Double Chain Silicates, 2nd Edition.* The Geological Society, London. Optical properties for magnesio-riebeckite and magnesio-arfvedsonite inserted by Douglas Kent at ESAT Region 8, October 2008.

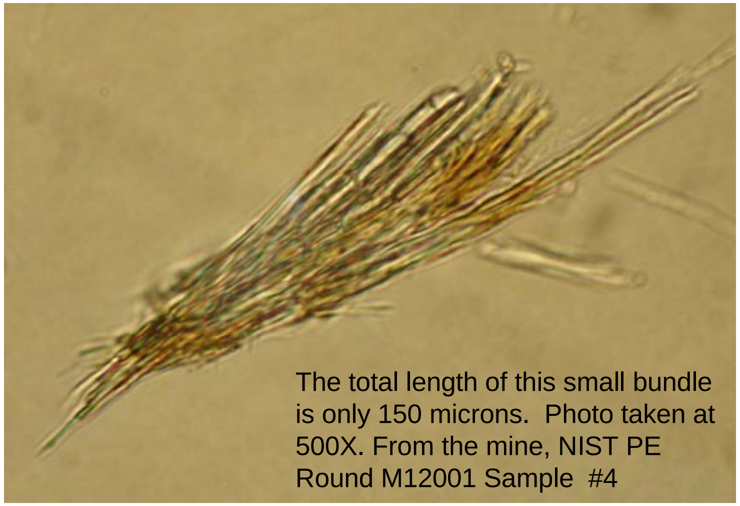
ATTACHMENT 5

PLM Photomicrographs Demonstrating a Wide Range of Libby Amphibole Morphologies

PLM Photomicrographs of Typical Libby Amphibole Morphology

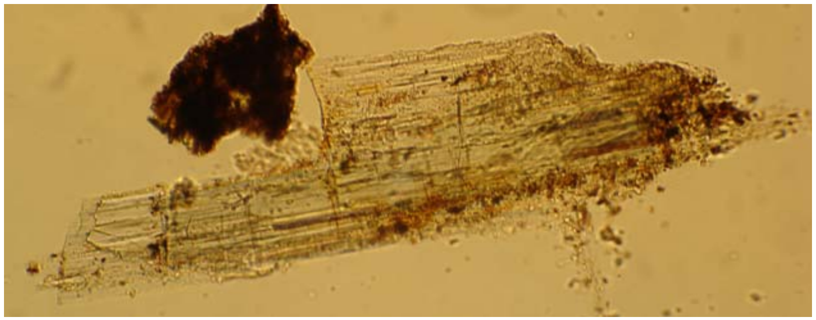






Prismatic Libby Amphibole

The optical properties are the same as they are for more fibrous forms of LA. Colors of winhcite, richterite, tremolite, and actinolite are generally much paler than those of hornblende, which is usually dark green to dark blue-green to brownish green. Hornblende also has higher refractive indices (in the range of 1.65 to 1.68) than Libby Amphibole.



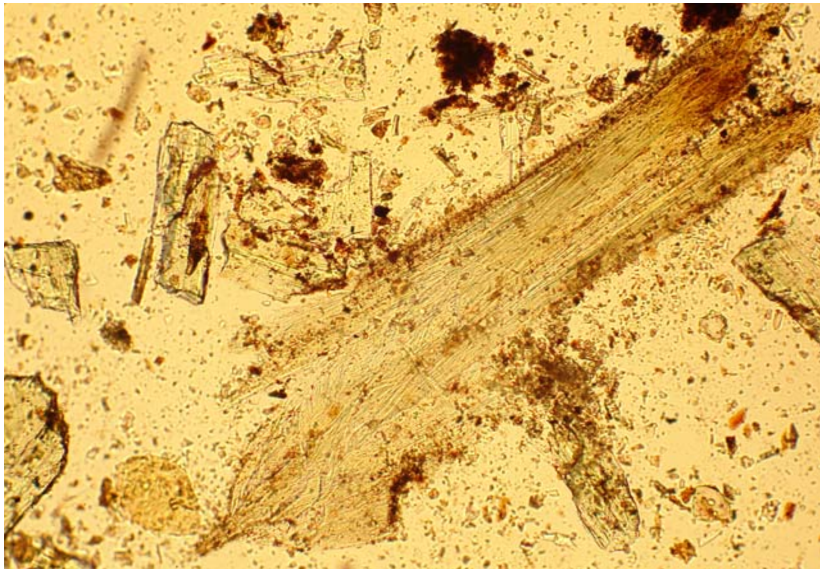
From a Libby Asbestos Superfund Site field sample

From the mine, NIST PE Round M12001 Sample #4

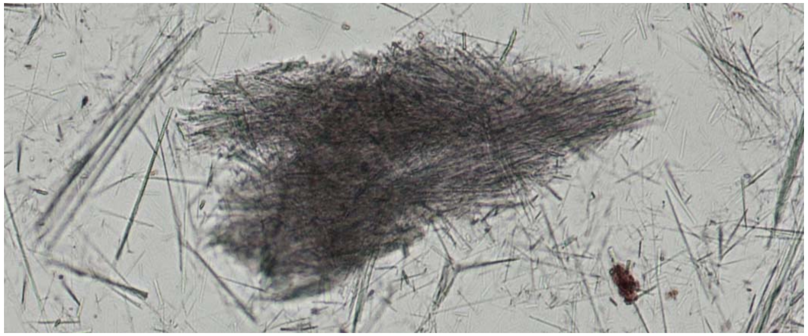
From the mine, NIST PE Round M12001 Sample #4

From a Libby Asbestos Superfund Site field sample

Some Libby Amphibole shows a “matted” or “felted” morphology. The internal structure of these bundles is still fibrous. The green high-relief prismatic crystals in the top right photo are hornblende. The bundles in the two top photos were found in Libby Asbestos Superfund Site field samples. The bundles in the lower two photos are from the NIST PE Round M12001 Sample #4, from the mine.



The fibers on the right side of this bundle are completely matted.



A “felted” bundle plus some smaller acicular fibers. The photos on this page are all of bundles found in field samples collected from the Libby Asbestos Superfund Site.

A large bundle with many smaller acicular fibers.

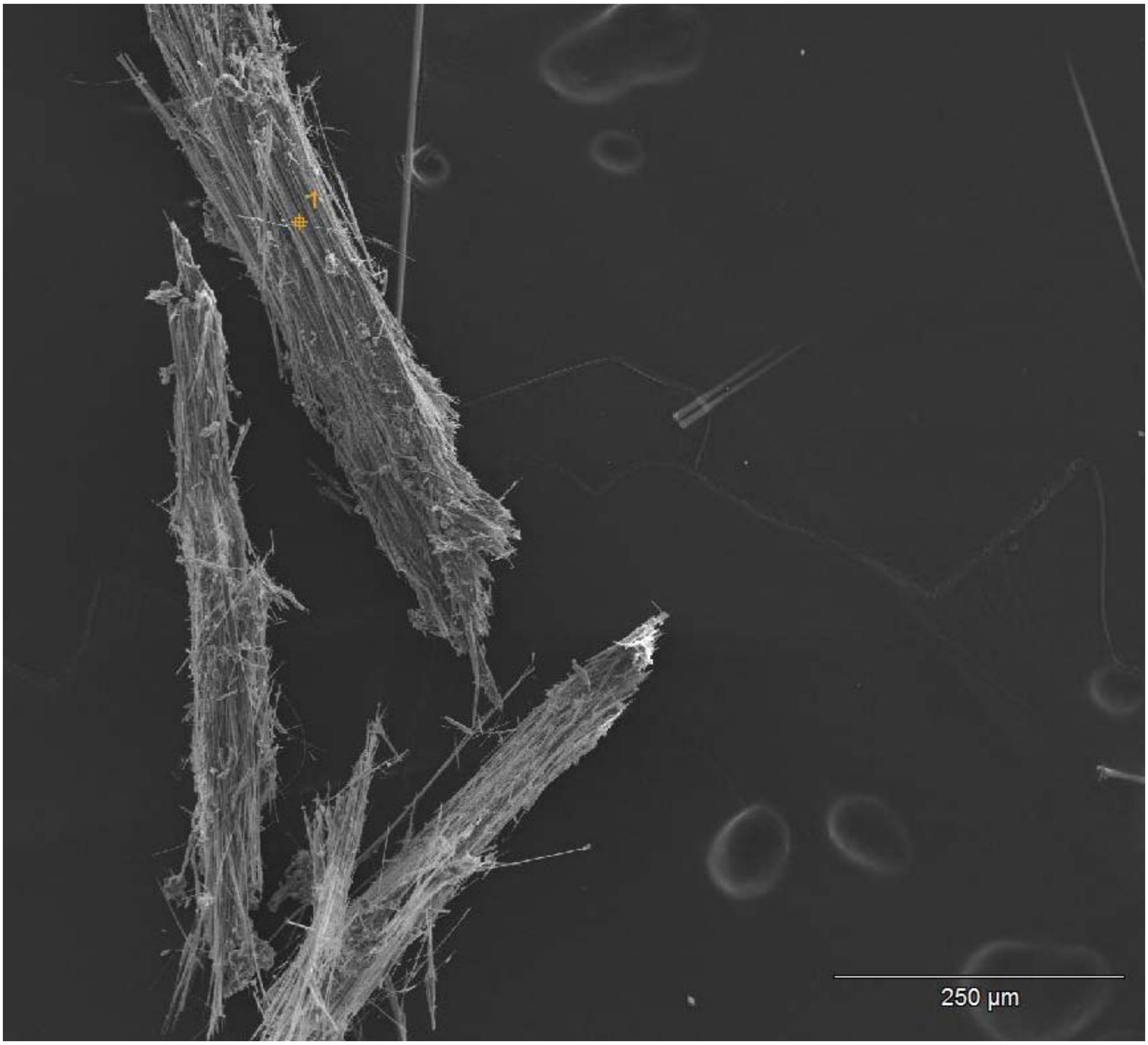
ATTACHMENT 6

SEM Photomicrographs of Representative Examples of Libby Amphibole Morphologies

SEM Photomicrographs of Representative Examples of Libby Amphibole Morphology

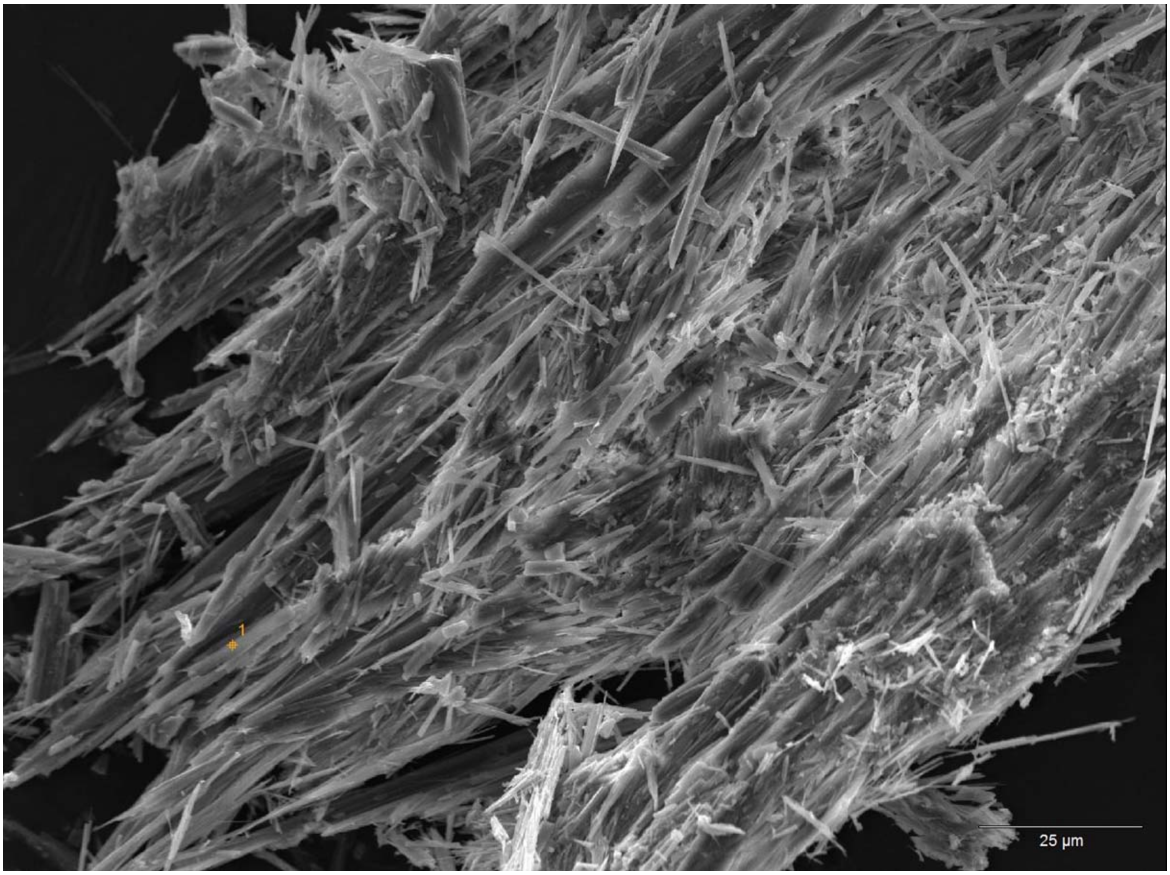
Individual bundles of Libby Amphibole were picked from soil samples at the ESAT Region 8 Laboratory and prepared for analysis by scanning electron microscopy (SEM). Slide mounts of these bundles were initially prepared in a refractive index liquid and the bundles were examined by PLM. Then the refractive index liquid was evaporated off the slides on a hot plate in a fume hood and the bundles of LA were transferred to a SEM stub. Fibers were selected for SEM analysis that showed examples of the range of LA morphologies that may be encountered in field samples. During SEM analysis, energy dispersive spectrometry (EDS) was performed on these fiber bundles and their EDS spectra were found to be consistent with Libby Amphibole.

The SEM analysis was performed by the United States Geological Survey (USGS). Ten of the photomicrographs taken of the LA bundles by the USGS are provided here as a reference to help laboratories understand the range of morphologies of Libby Amphibole that they may encounter in field samples. All of the following pictures are of bundles that were found in field samples collected from the Libby Asbestos Superfund Site in Montana.



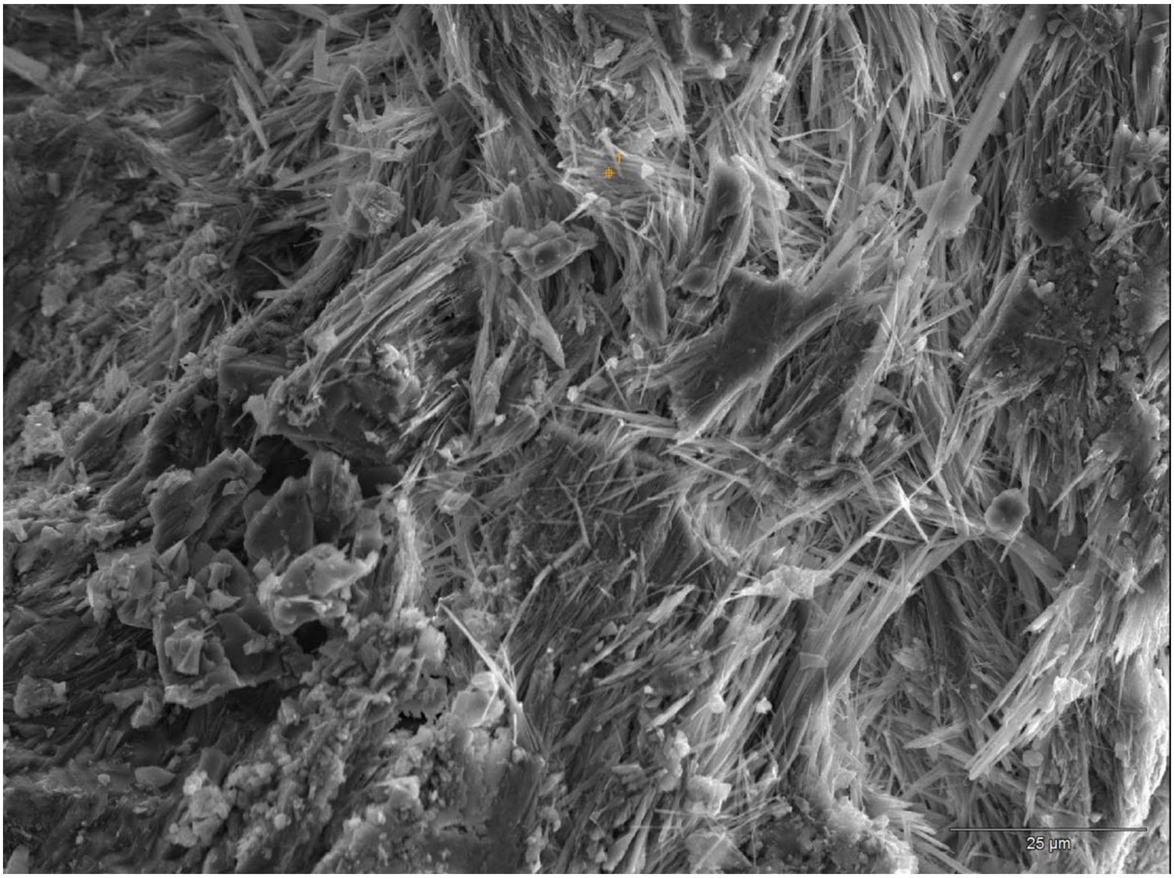
These are typical bundles of Libby Amphibole where the average aspect ratio of the fibers is high and most of the fibers are nearly parallel to one another. Note the scale in microns at the bottom of the photo. These three bundles are all of a size that can be seen with a stereomicroscope and picked out to be placed on a slide for analysis by PLM. The small number “1” at the top of the photo indicates where an EDS spectrum was taken and saved to a file.

Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.



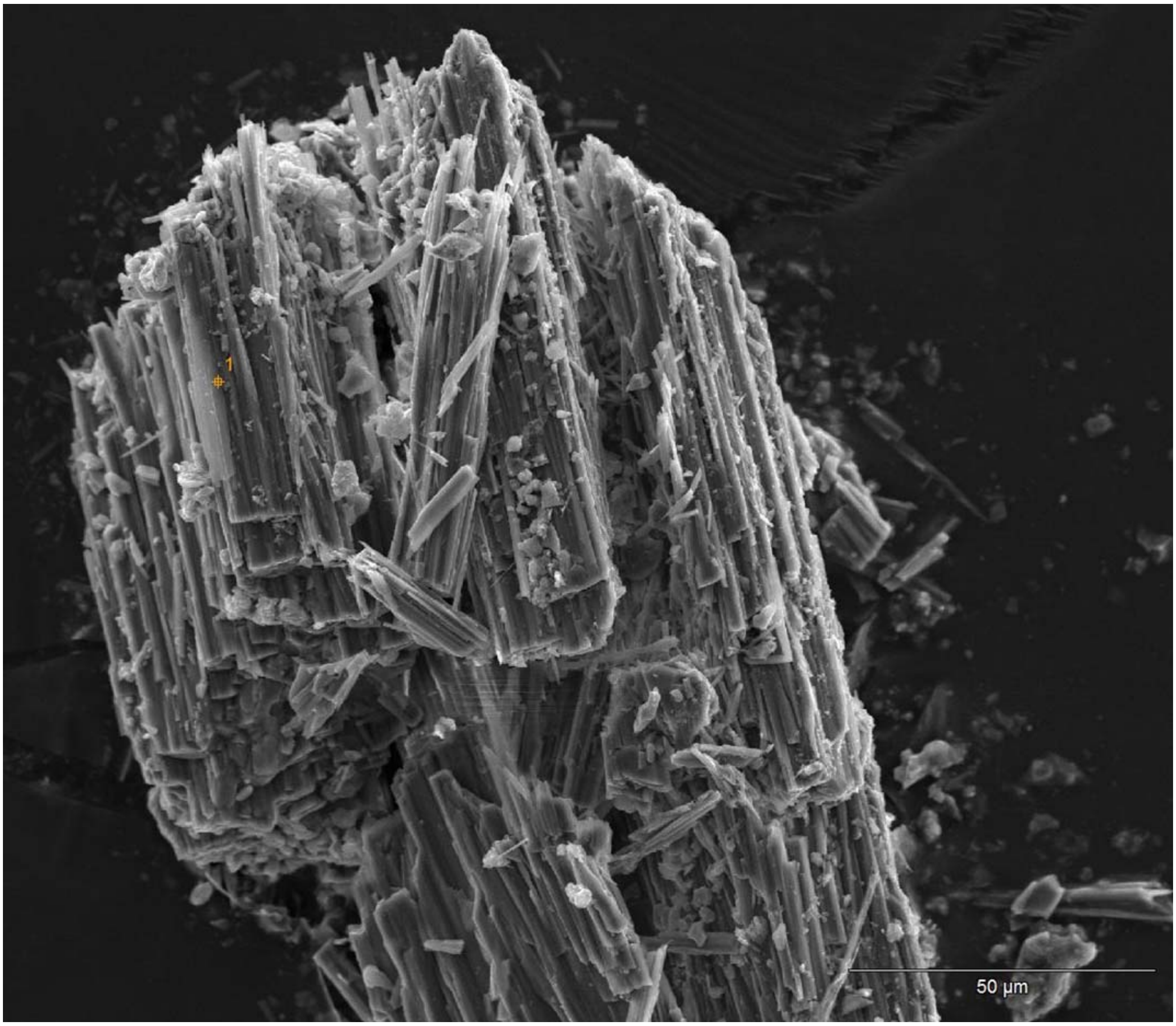
Varying degrees of parallelism can be seen in the fibers that compose bundles of Libby Amphibole. Note that the fibers in this bundle of LA are less parallel than the fibers in the bundles in the previous example.

Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.



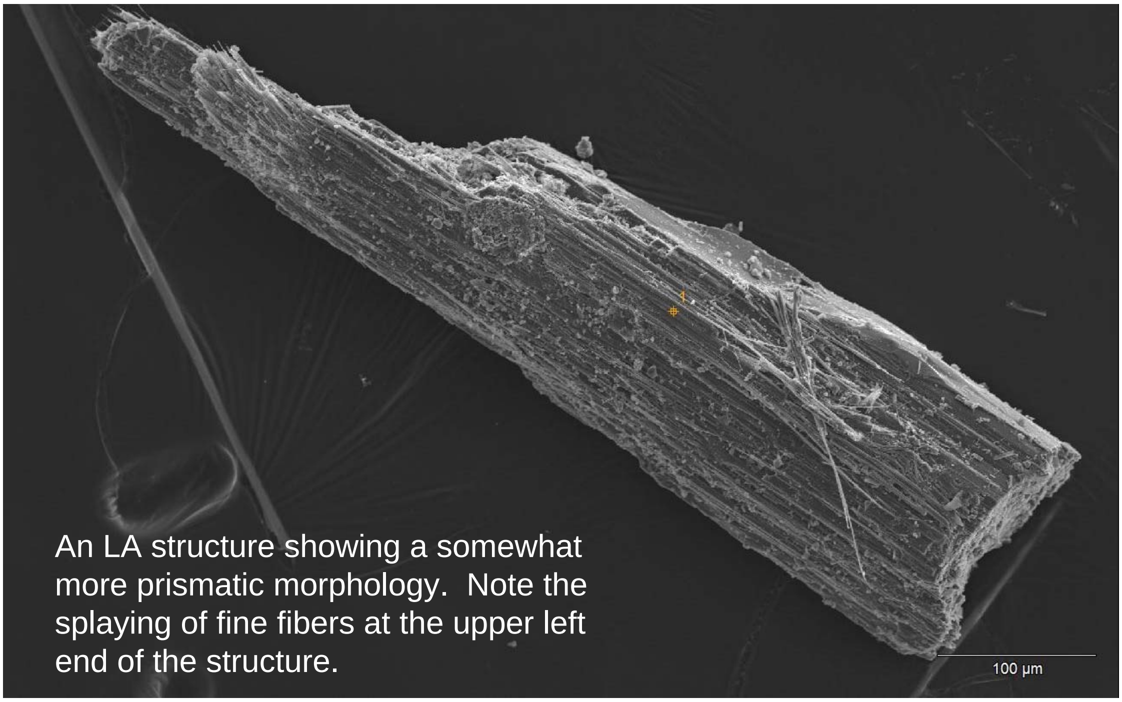
When this bundle of Libby Amphibole was viewed under PLM, its morphology was described as “felted”, or “matted”, with the fibers crossing at high angles to one another. This is how the bundle appeared when it was subsequently viewed by SEM. The fibrous nature of the “felted” or “matted” morphology is clear at this scale.

Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.

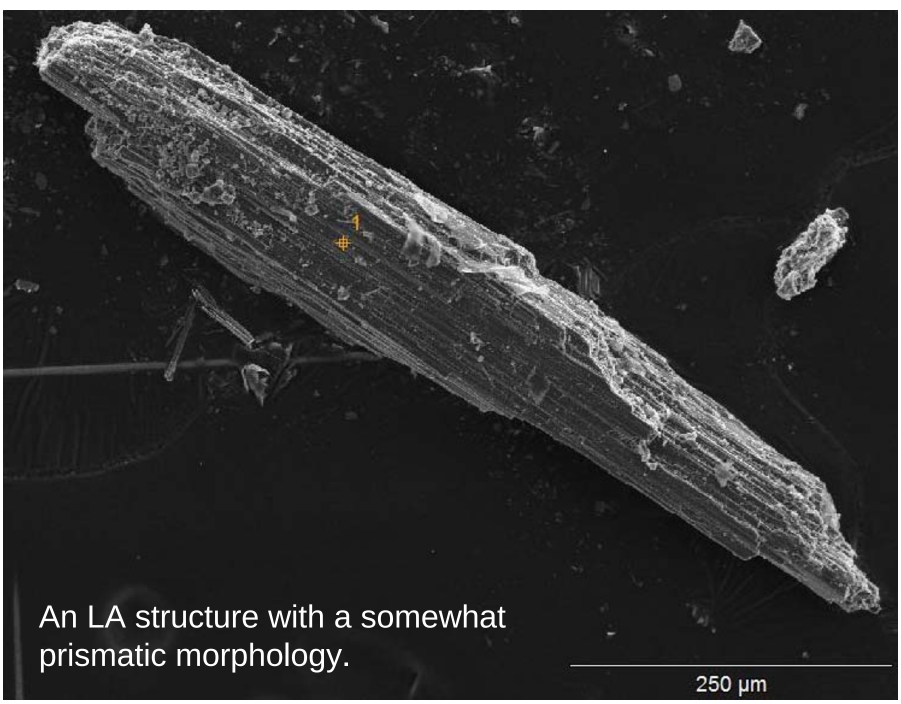


The average aspect ratio of the fibers in this bundle of LA is lower than those of the bundles in the previous examples. However, as seen by SEM, the bundle still splits readily into many small fibers.

Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.

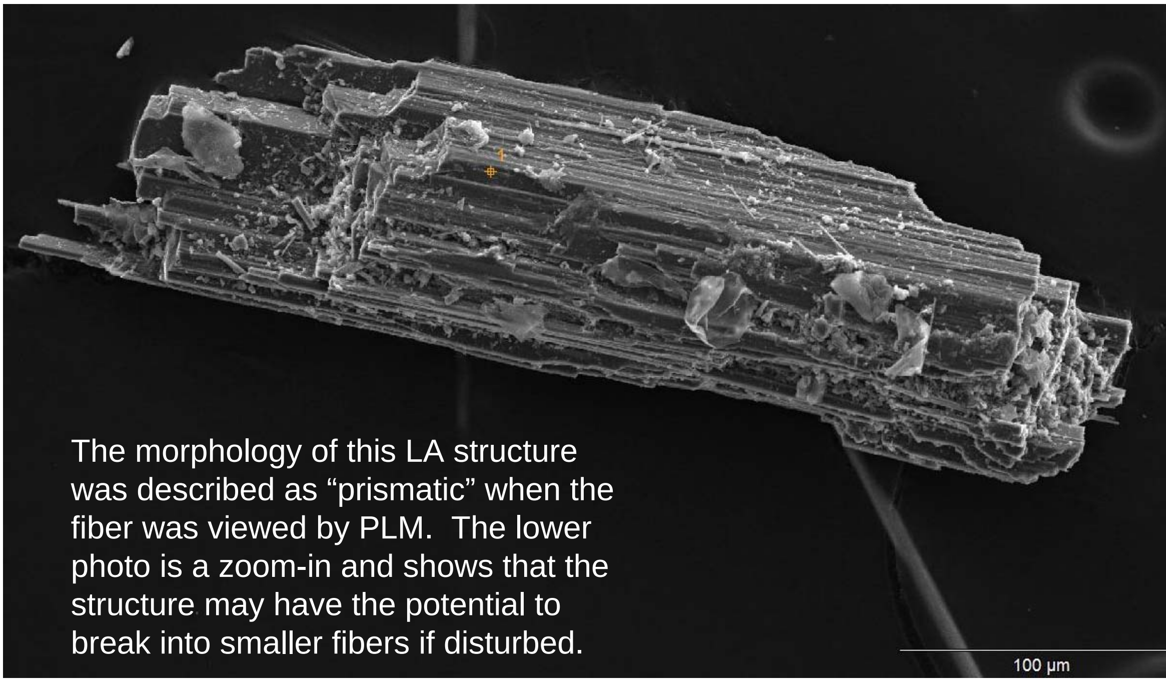


An LA structure showing a somewhat more prismatic morphology. Note the splaying of fine fibers at the upper left end of the structure.

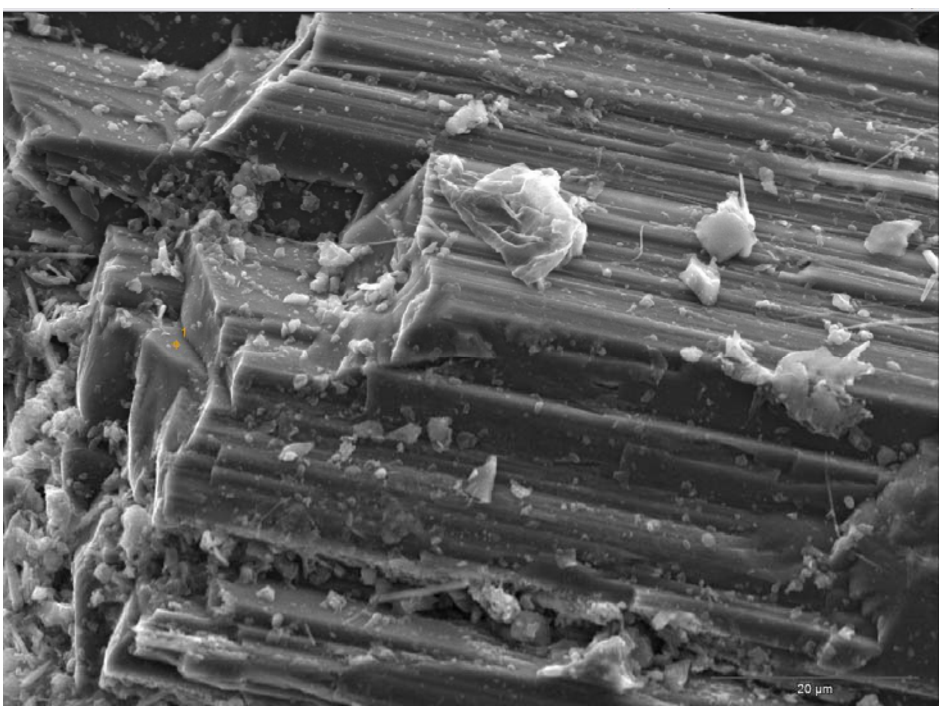


An LA structure with a somewhat prismatic morphology.

Photographs provided by the USGS and used by permission. Photos for use by the Libby Lab Team only- do not cite or distribute.



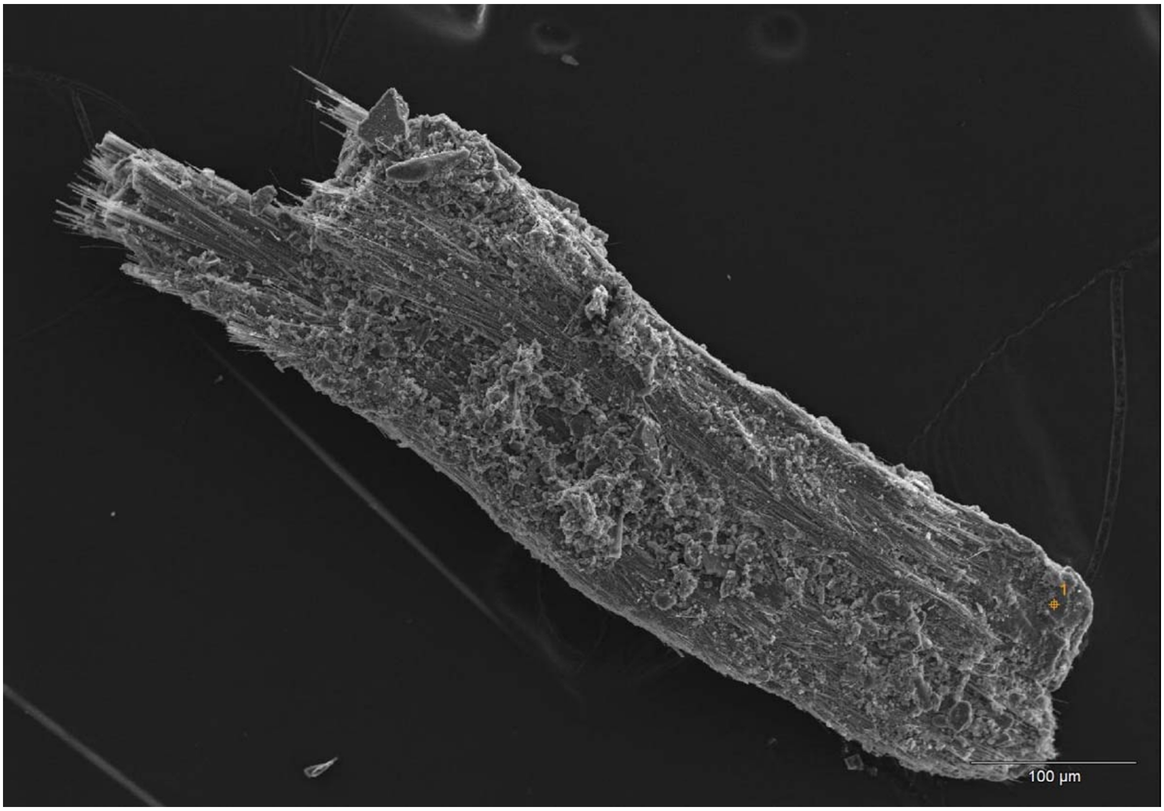
The morphology of this LA structure was described as “prismatic” when the fiber was viewed by PLM. The lower photo is a zoom-in and shows that the structure may have the potential to break into smaller fibers if disturbed.



Photographs provided by the USGS and used by permission. Photos for use by the Libby Lab Team only- do not cite or distribute.

This bundle of LA was found either adhered to or grown on a piece of feldspar. Energy dispersive spectrometry (EDS) of the blocky material on the left half of the structure was found to be consistent with potassium feldspar. EDS of the fibrous material on the right, as with all other fiber bundles shown in these photos, was found to be consistent with Libby Amphibole.

Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.



This is a bundle of LA that was found in PLM as either adhered to or grown on a piece of mica. This is how the bundle appeared when it was subsequently viewed by SEM. The EDS spectrum of the platy, rounded material at the lower right end of the structure was found to be consistent with biotite. The EDS spectrum of the fibrous material on the upper left end of the structure was found to be consistent with Libby Amphibole.

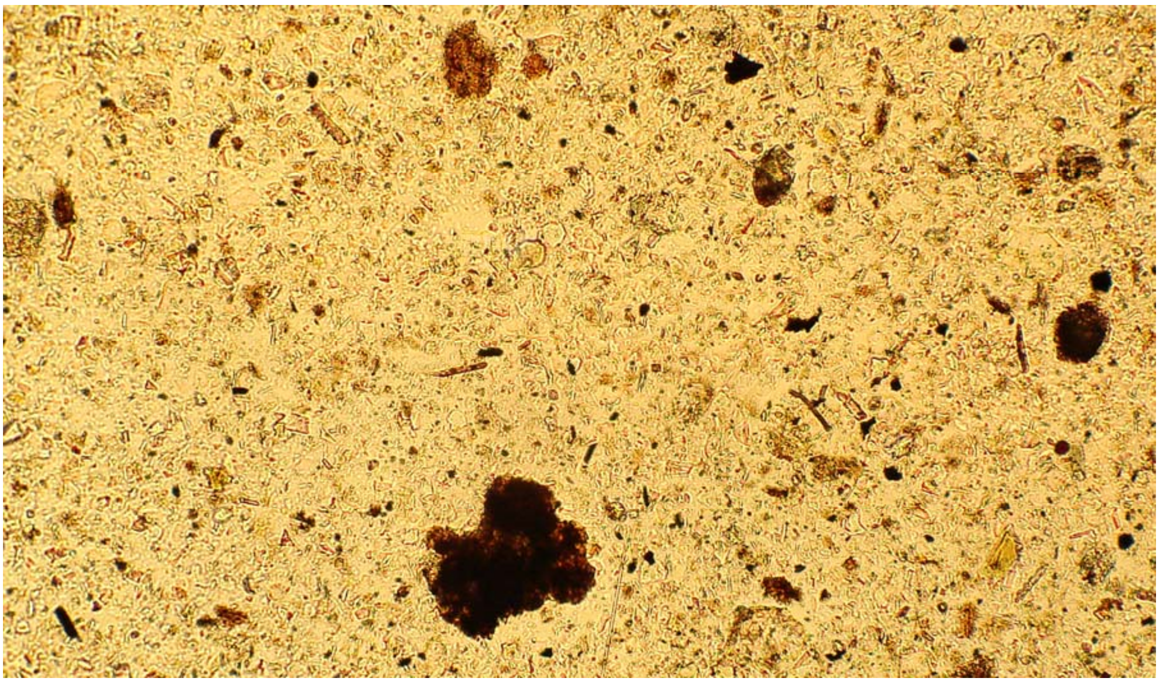
Photograph provided by the USGS and used by permission. Photo for use by the Libby Lab Team only- do not cite or distribute.

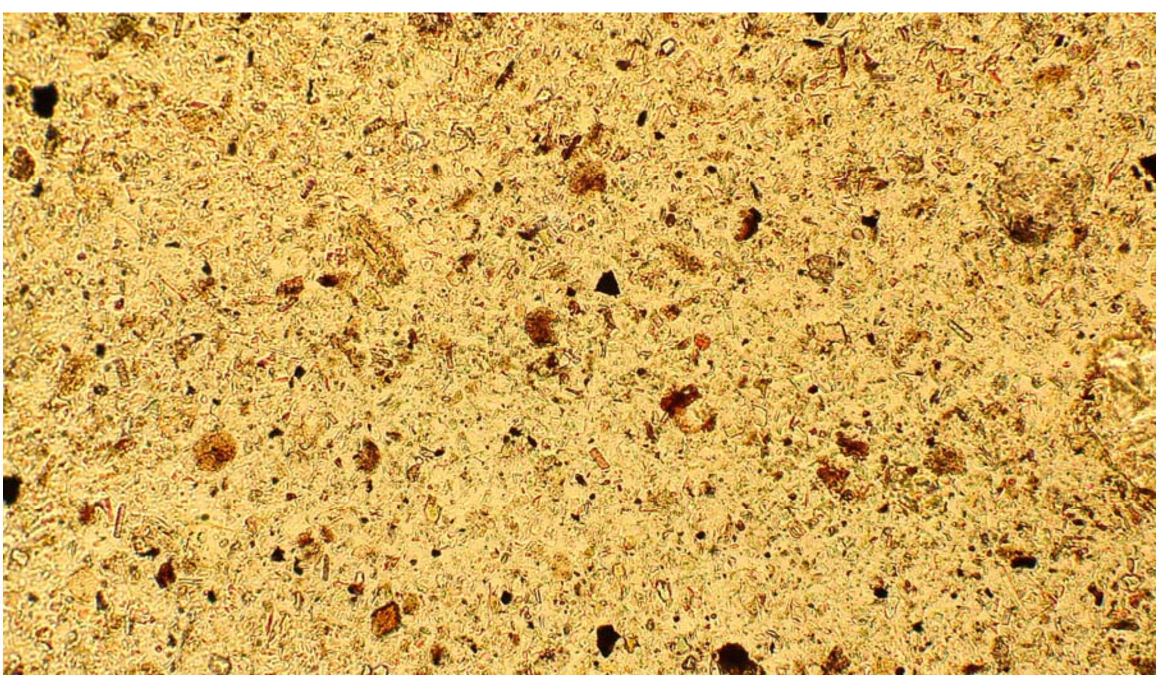
ATTACHMENT 7

Photomicrographs of Representative Fields of View of 0.2% and 1.0% Libby Amphibole Reference Materials

0.2% Libby Amphibole

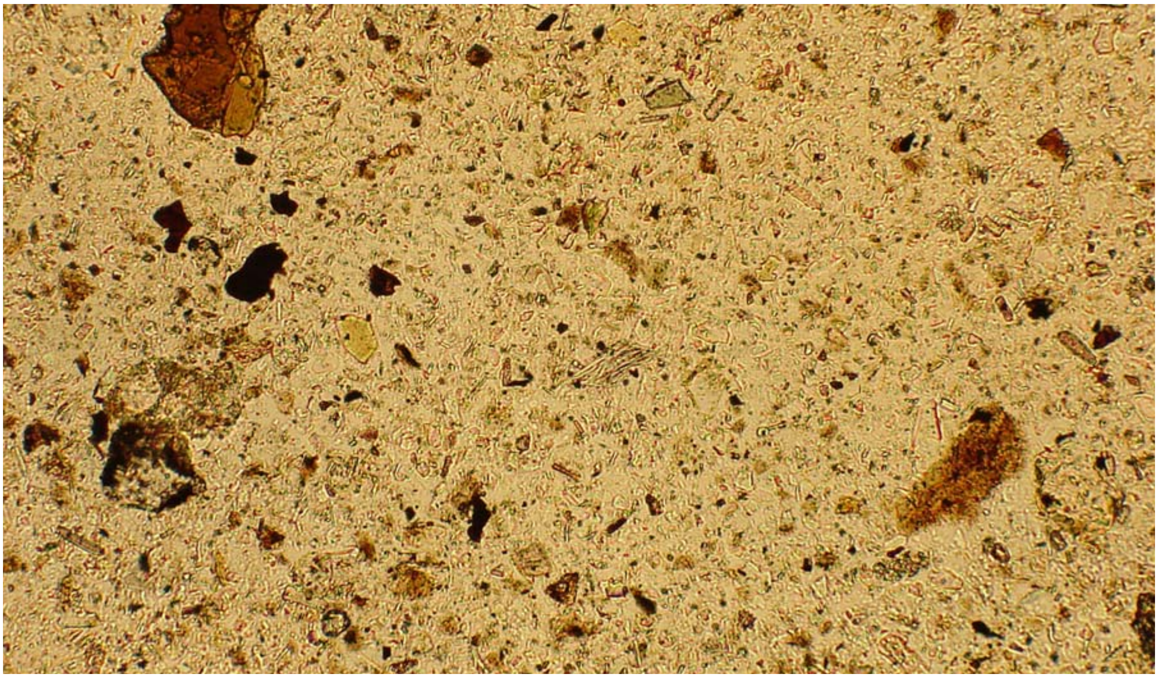
Photomicrographs of representative fields of view of the 0.2% Libby Amphibole by weight Controlled PE Reference Material. All photos taken at 100x, plane light in 1.55 refractive index oil. Width of each picture is approximately 1,500 microns.

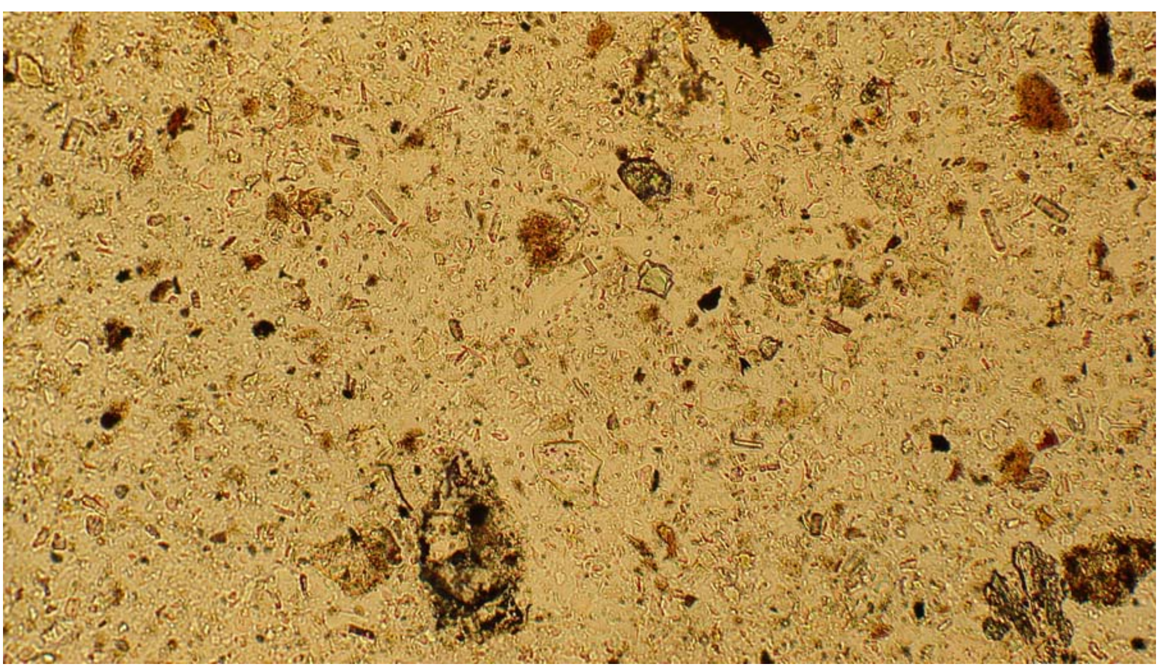




0.2% Libby Amphibole

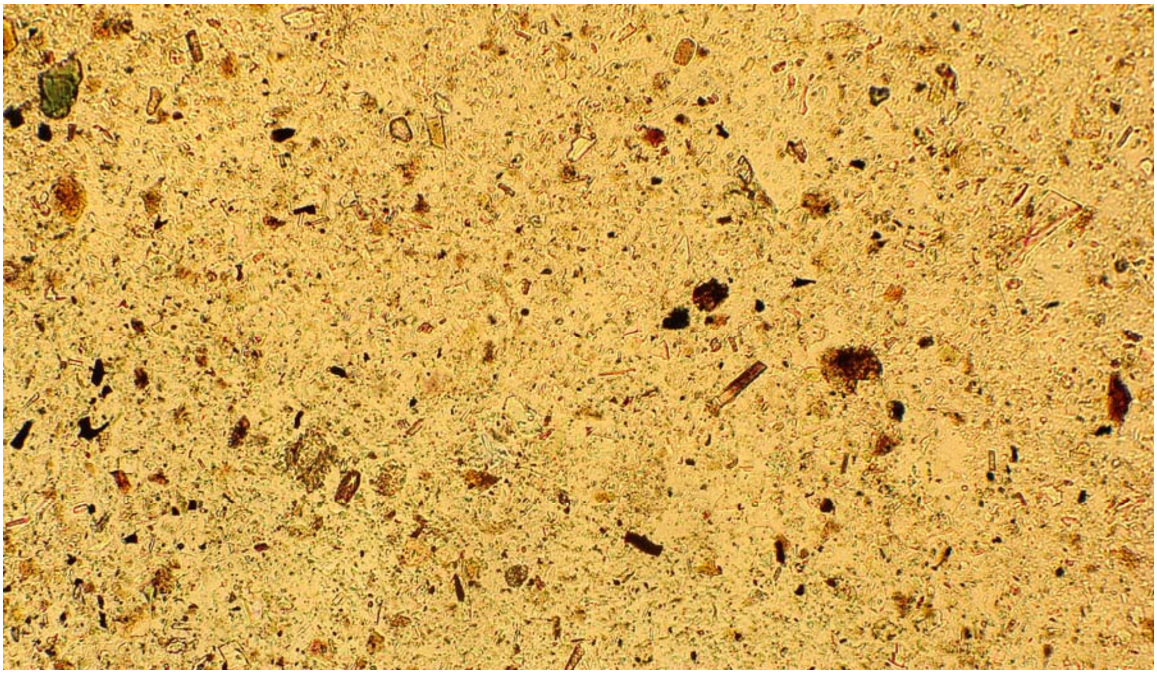
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

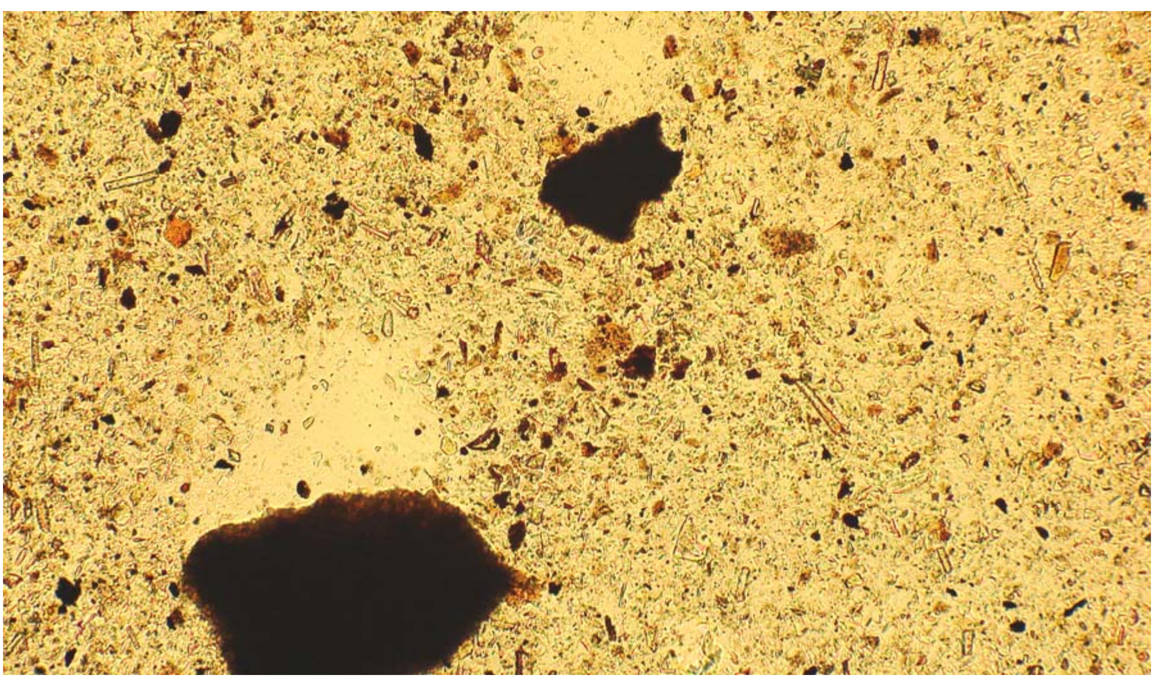




0.2% Libby Amphibole

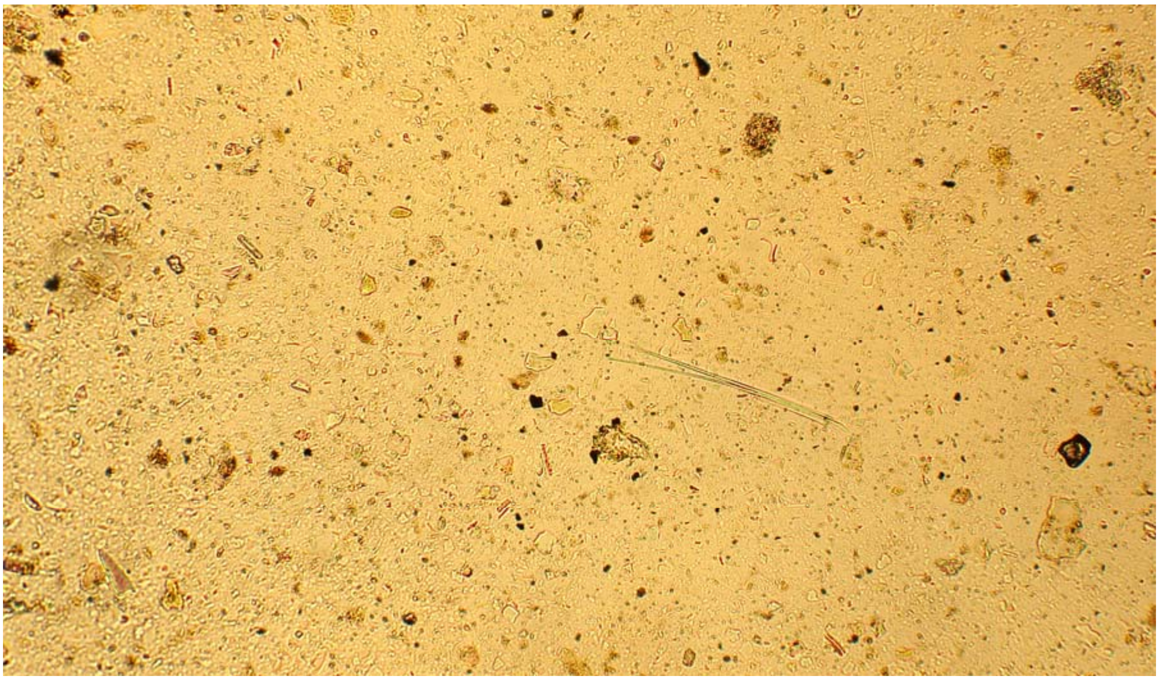
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

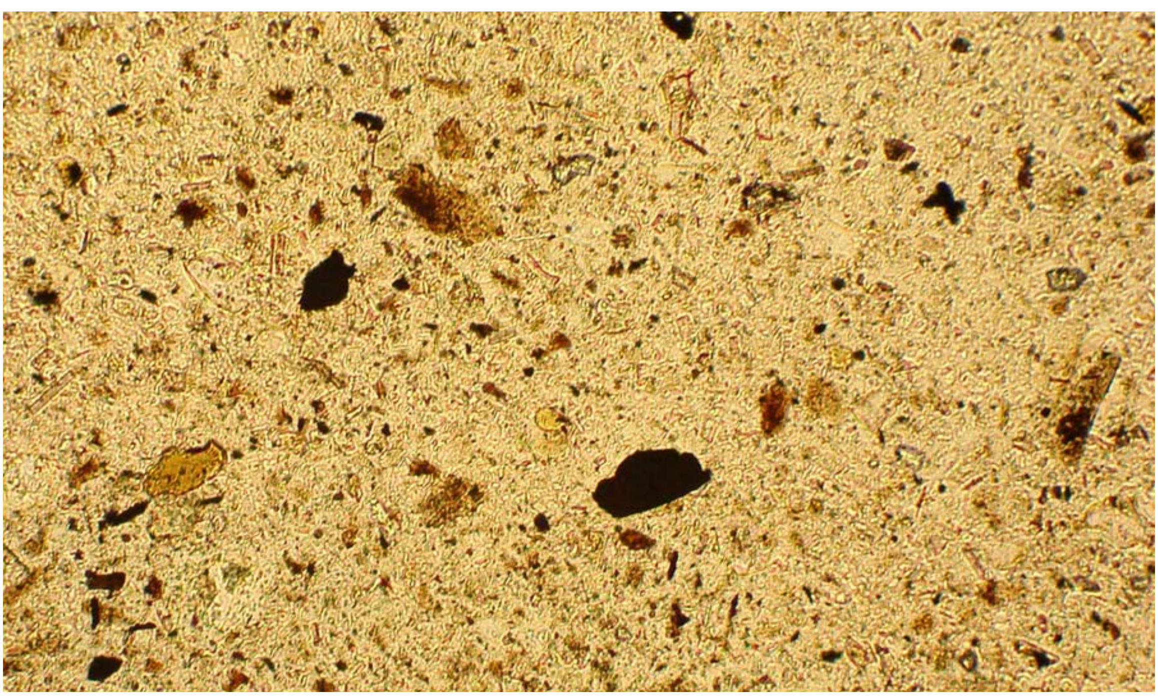




0.2% Libby Amphibole

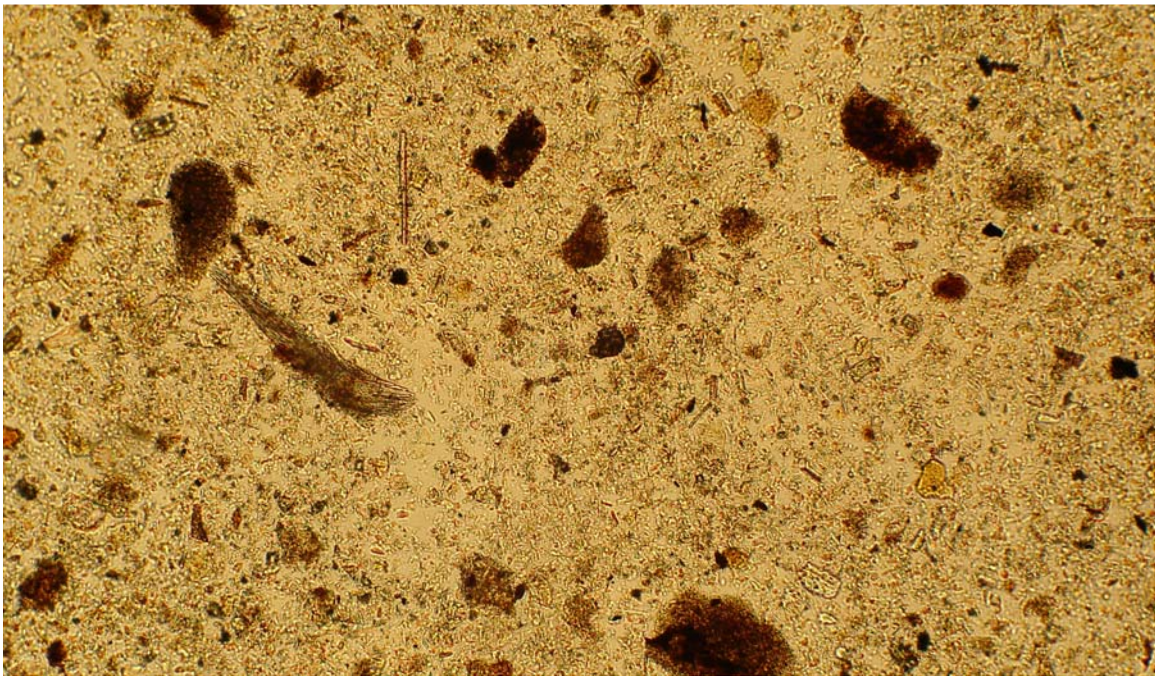
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

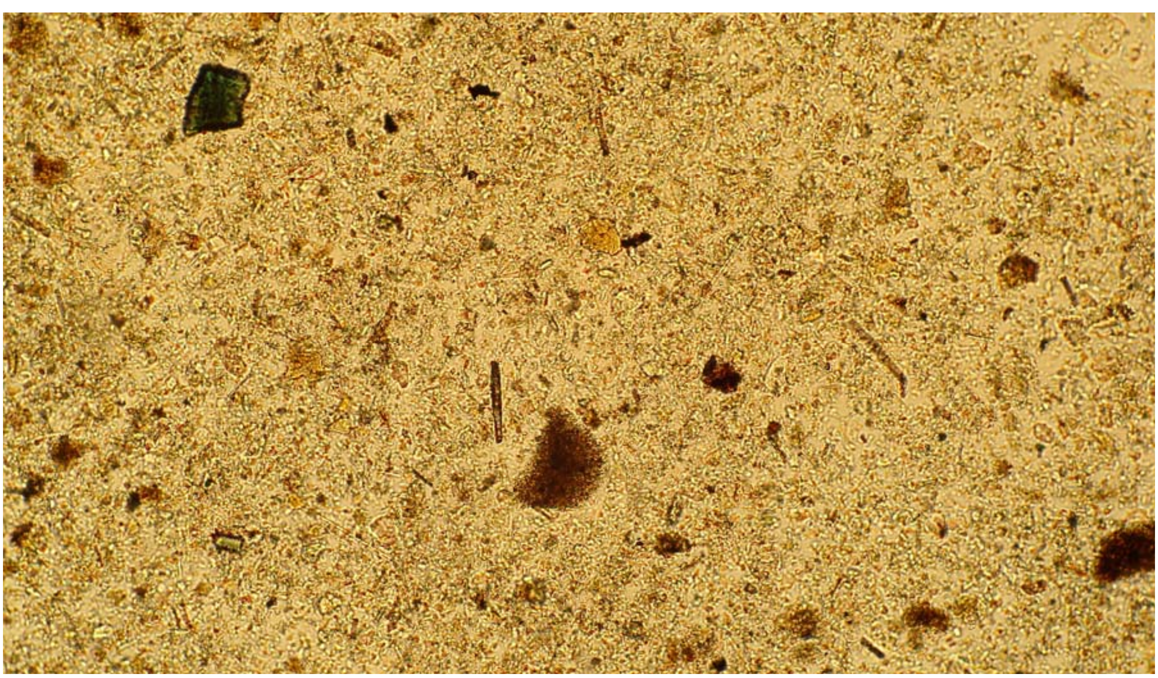




1.0% Libby Amphibole

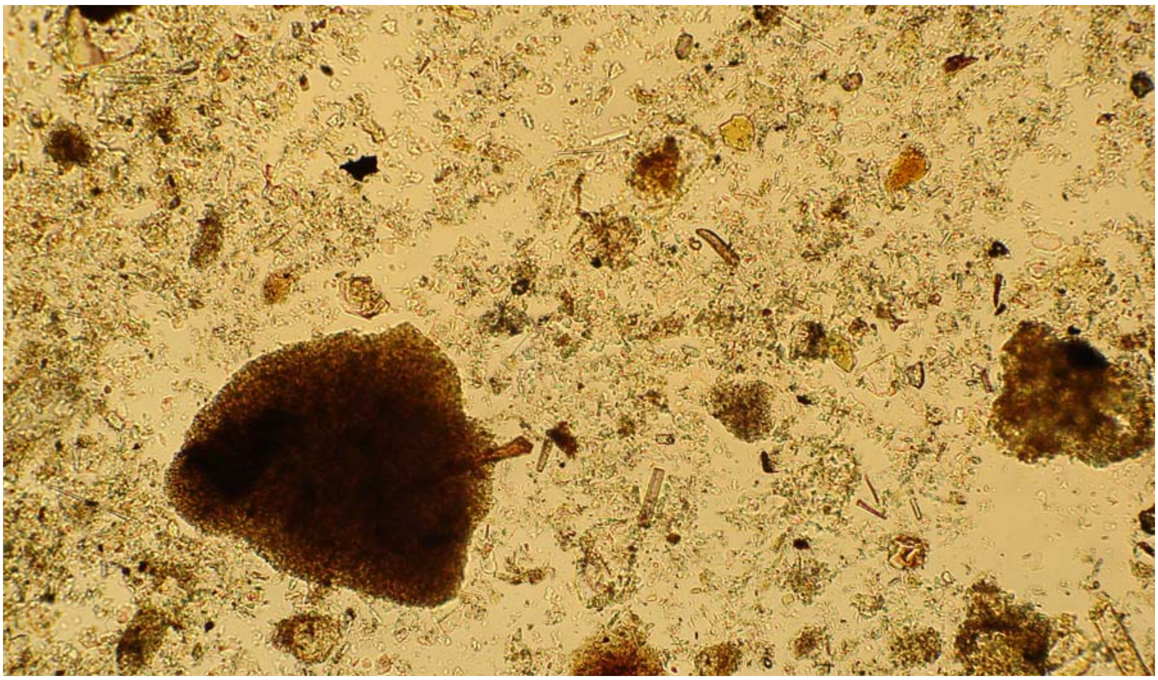
Photomicrographs of representative fields of view of the 1.0% Libby Amphibole by weight Controlled PE Reference Material. All photos taken at 100x, plane light in 1.55 refractive index oil. Width of each picture is approximately 1,500 microns.

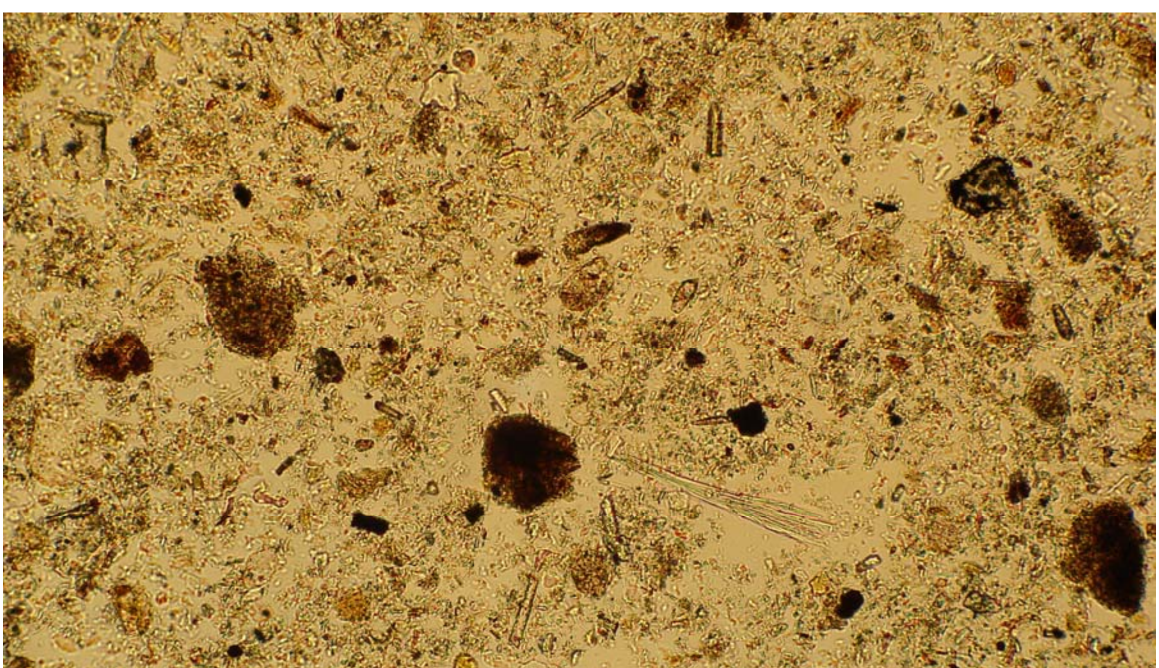




1.0% Libby Amphibole

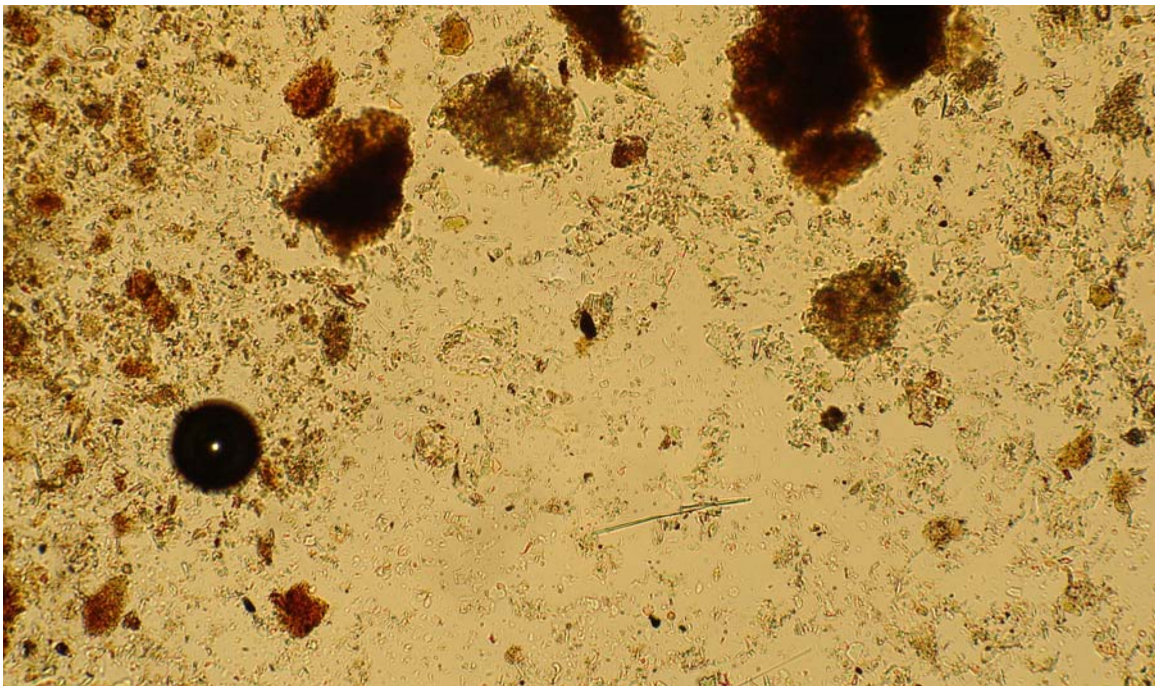
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

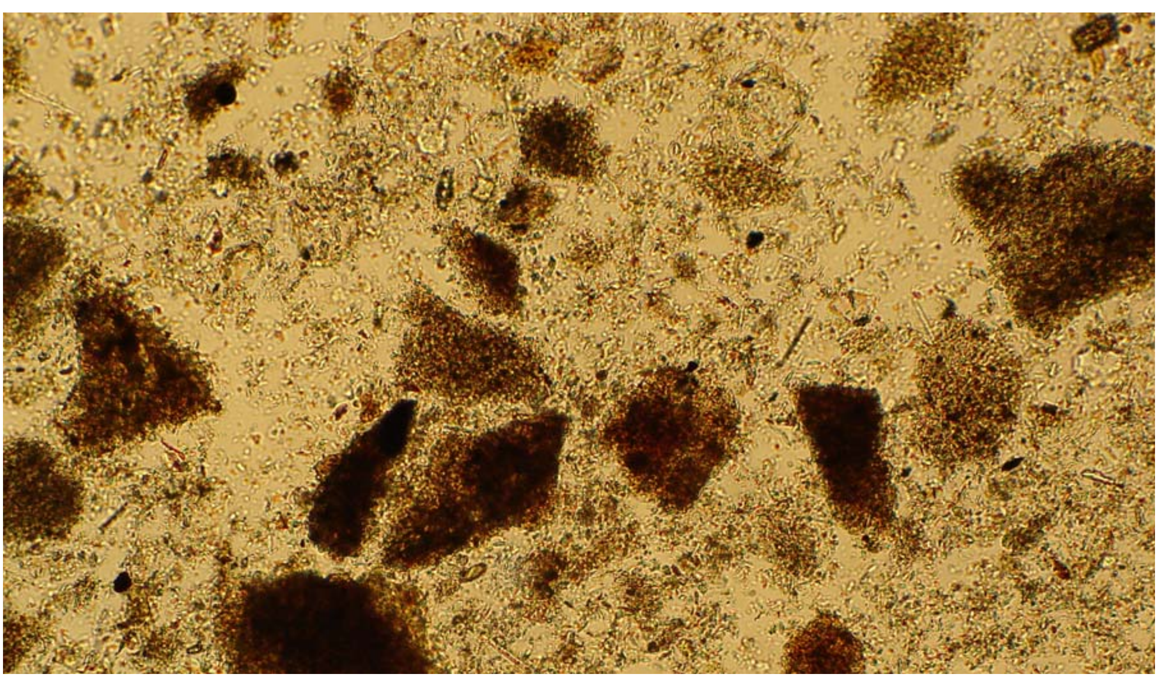




1.0% Libby Amphibole

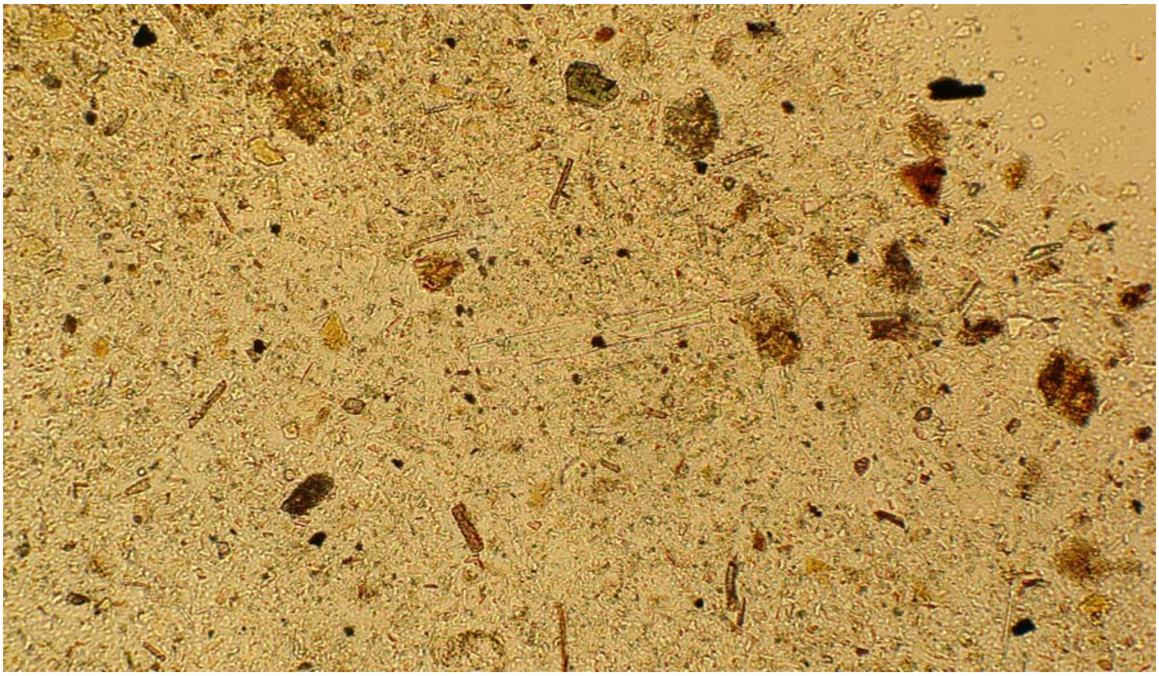
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

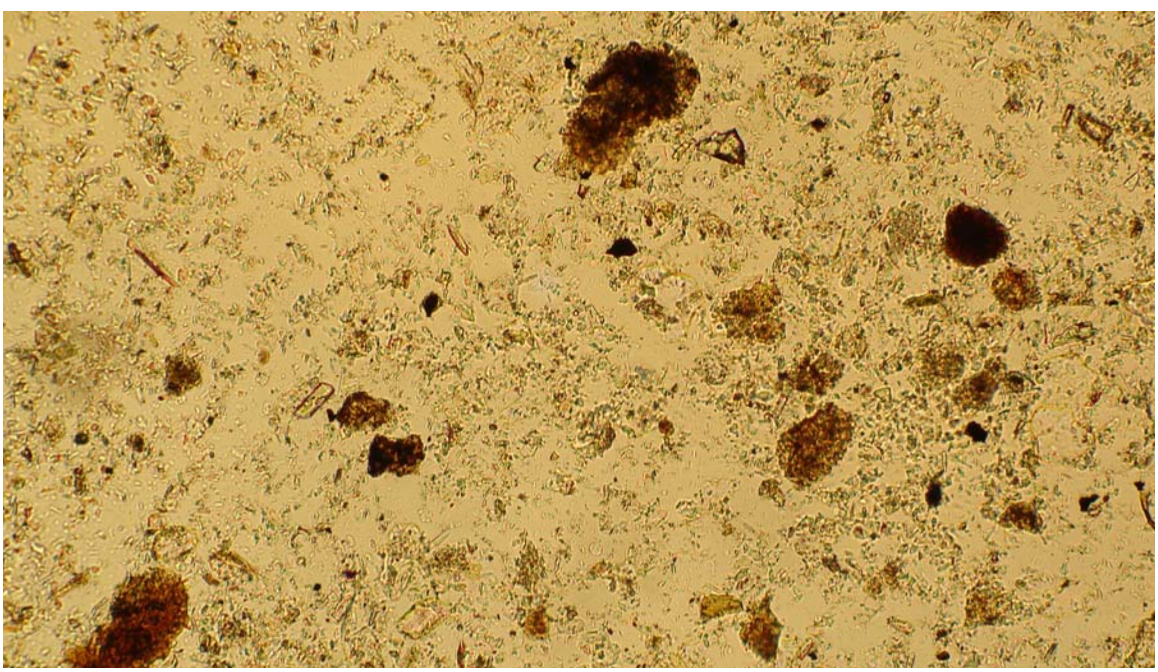




1.0% Libby Amphibole

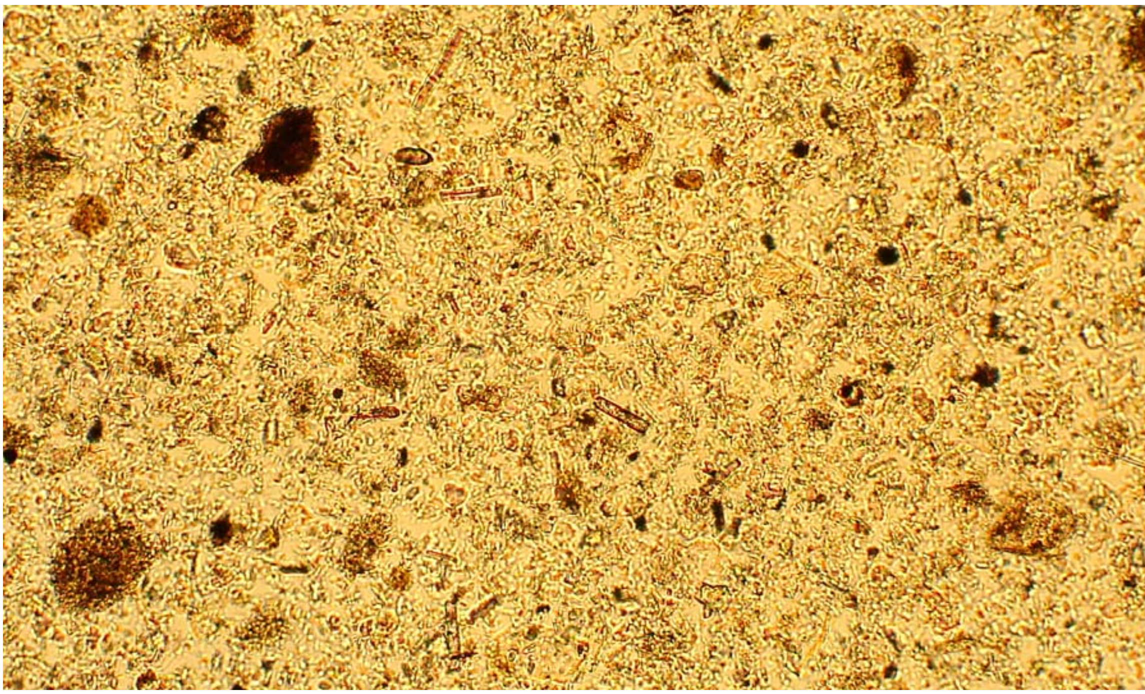
Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

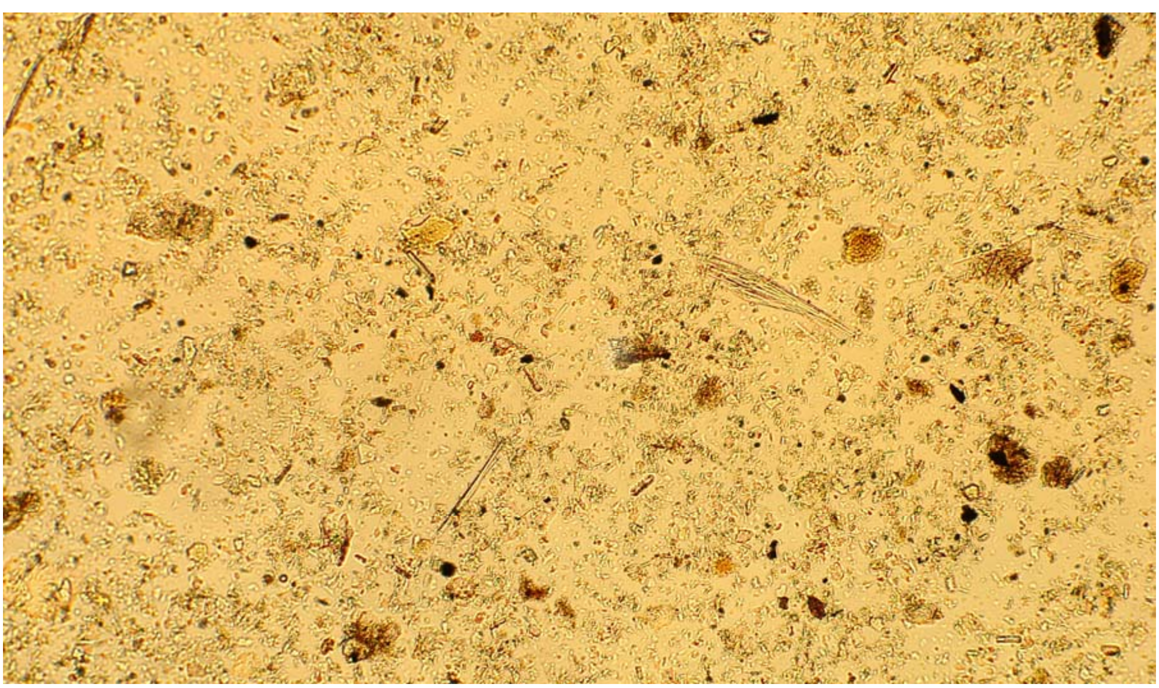




1.0% Libby Amphibole

Photomicrographs of representative fields of view. Width of each picture is approximately 1,500 microns.

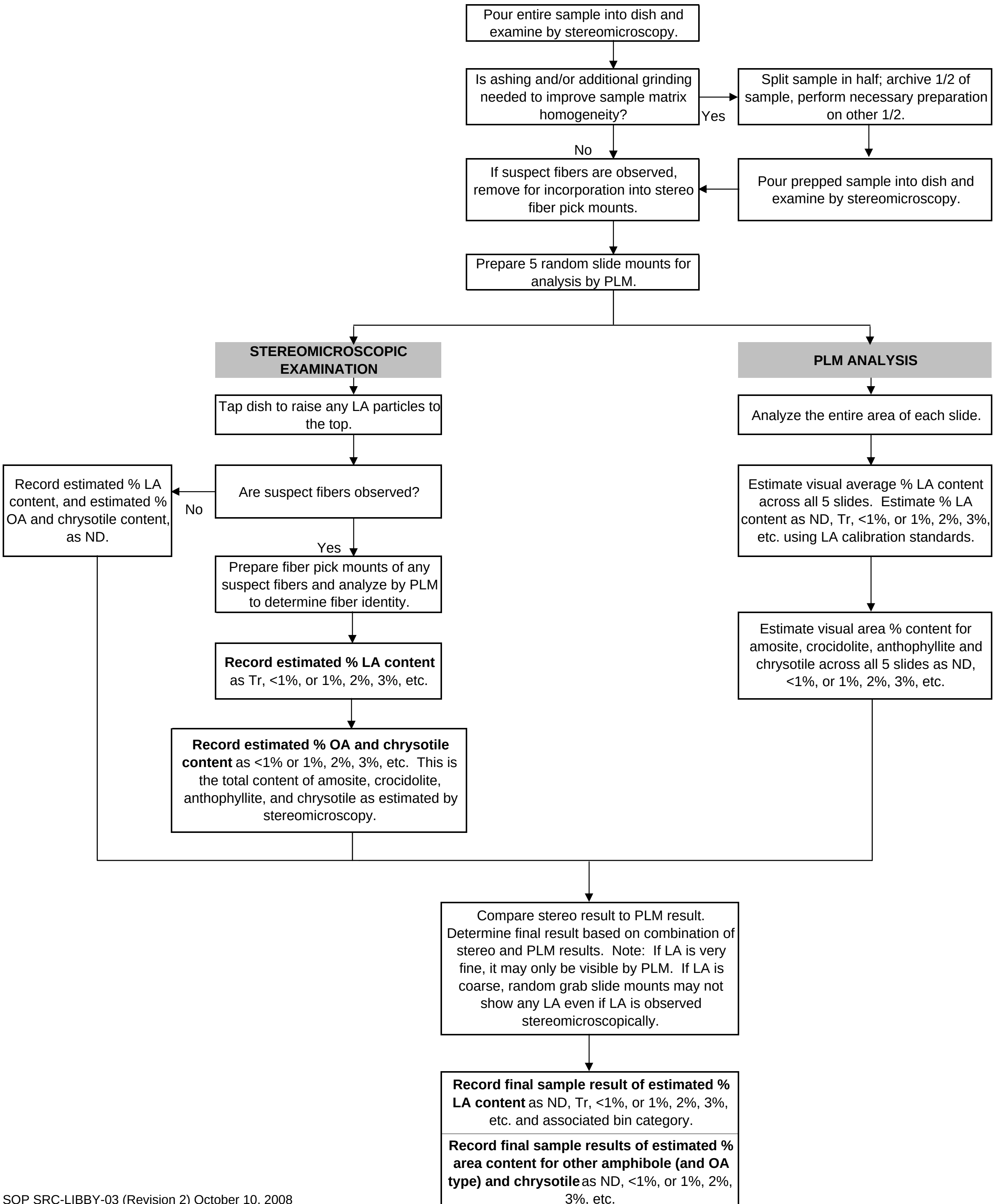




ATTACHMENT 8

Flow Chart for Determining Asbestos Content by Complementary Use of Stereomicroscopic Examination and PLM Visual Estimation

Flow Chart for Determining Asbestos Content by Complementary Use of Stereomicrosopic Examination and PLM Visual Estimation



Date: August 12, 2003 SOP No. SRC-LIBBY-05 (Revision 0)

Title: **COLLECTION AND ANALYSIS OF ASBESTOS IN INDOOR DUST**

Author: William Brattin

SYNOPSIS: A standard method for collecting and analyzing indoor dust samples for asbestos is provided. This method is based on ASTM Method D5755-95, with project-specific modifications intended specifically for use at the Libby Superfund Site.

APPROVALS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
USEPA Region 8	Jake Goldade	8/12/03
Syracuse Research Corp.	W J Brattin	8/12/03

Revision	Date	Principal Changes
0	08/12/03	--

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide a standard approach for collection of indoor dust samples and analysis of those samples for asbestos. This SOP is based on ASTM Method D5755-95, with project-specific modifications specifically intended for application at the Libby Superfund site.

2.0 SCOPE AND APPLICATION

This method is intended for preparation and analysis of samples collected for asbestos in indoor dust using ASTM Method D5755-95. This method is appropriate for the preparation and analysis of all types of asbestos fibers, including both chrysotile and amphiboles, including amphiboles that are characteristic of the Libby site

3.0 RESPONSIBILITIES

It is the responsibility of the laboratory supervisor to ensure that all analyses and quality assurance procedures are performed in accord with this SOP, and to identify and take appropriate corrective action to address any deviations that may occur during sample preparation or analysis. The laboratory supervisor should also communicate with project managers at EPA or their oversight contractors any situations where a change from the SOP may be useful, and must receive approval from the EPA Remedial Project Manager or Regional Chemist for any deviation or modification from the SOP before proceeding with sample preparation and analysis.

4.0 METHOD DESCRIPTION

Dust samples are collected in a filter cassette using a microvacuum device. Dust in the cassette is suspended in water and a portion of the suspension is applied to a filter and analyzed for asbestos using transmission electron microscopy (TEM).

5.0 DETAILED METHOD

Dust samples are collected and analyzed in accord with ASTM D5755-95, except for the project-specific modifications, clarifications, and requirements provided below.

1. Sample Collection

Samples will be collected using 25 mm MCE filters. The number of 100-cm^2 templates collected should be specified in the project-specific plan. In general, a composite of at least three template areas is desired in order to ensure that the sample is representative.

2. Classification of Asbestos Mineral Type

Based on fiber attributes (morphology, SAED, EDXA), asbestos in the sample is classified into one of three categories:

Mineral Class	Description
Libby Amphibole (LA)	Any amphibole asbestos similar to that observed in ores obtained from the mine in Libby. This solution series includes (but may not be limited to) actinolite, tremolite, richterite, and winchite, as well as magnesio-arfedsonite and ferro-edenite.
Other Amphibole (OA)	Other types of amphibole asbestos, including amosite, anthophyllite, and crocidolite. These forms of asbestos are not thought to be related to the mine in Libby.
Chrysotile (C)	Serpentine asbestos. This form of asbestos is the most common type in building materials, and is not thought to be related to the mine in Libby.

A discussion of the EDS spectrum associated with LA fibers is presented in USGS (2002).

3. Secondary Filter Loading

The volume of dust suspension applied to the secondary filter shall be sufficient to produce a total loading of $\leq$25%.

4. No Structures Detected

In a grid opening where no asbestos structures are detected, enter "ND" (rather than "NSD").

5. Analytical Sensitivity

Target sensitivity is 500 s/cm^2 or less, with a maximum of 1,000 s/cm^2. Whenever possible, sensitivity should be controlled by increasing the number of grid openings counted, up to a maximum of 20. If a sensitivity of 1,000 s/cm^2 cannot be achieved with 20 grid opening, the sample should be ashed in order to reduce debris loading (thereby allowing application of a larger fraction of the original sample to the secondary filter). If the necessary sensitivity cannot be achieved even after ashing, then the laboratory should complete a laboratory modification form to summarize the issues associated with that sample.

6.0 APPARATUS AND MATERIALS

All equipment and materials are as described in ASTM D5755-95.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

All QA/QC procedures are as described in ASTM D5755-95, except for the project-specific modifications, clarifications, and requirements provided below.

1. Field Blanks

Field blanks will be collected at a rate of one per sample team per day. The EPA regional chemist will specify the fraction of field blanks that must undergo analysis, as documented in a modification form LFO-000064. In the absence of any evidence of contamination, the rate will typically be one sample per team per week.

2. Re-Analysis

Each laboratory will prepare and analyze up to five different types of QC sample at the rates specified in Mod LB-000029.

8.0 RECORDS

8.1 Data Forms

Analysts will record analytical results using the electronic data sheets developed for the Libby project, as presented in the Dust Sampling and Analysis Plan (SAP). Once completed and checked, these spreadsheets are submitted to EPA for upload into the database. The laboratory should retain all original records for use in resolving any questions until otherwise instructed by EPA.

8.2 Instrument Maintenance Logbook

An individual instrument maintenance logbook should be kept for each piece of equipment in use at the laboratory. All maintenance activities must be recorded in the appropriate logbook.

8.3 Data Storage and Archival

Electronic Data. Each day of data acquisition, all electronic files will be saved onto two separate media. For example, the data may be saved onto a computer hard drive, but must also be backed up onto a type of portable media such as CD-ROM, floppy disc, or tape. Portable media will be maintained in a single location with limited access.

Hardcopy Data. All data sheets and micrographs must be stored in a secured location with limited access (e.g., locking file cabinet) when not in use.

Copies (hardcopy and electronic) of the raw analytical data will be submitted to USEPA for archival.

9.0 REFERENCES

ATSM. 1995. Standard Test method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations. American Society of Testing and Materials. Method Designation D 5755-95. October, 1995.

APPENDIX C
Inspection Forms

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LIBBY ASBESTOS SITE
Occupant Information Form (OIF)

General Information					
Address:					
Property ID:					
Location ID:					
Location Type:					
Location Description:					
Survey Date (Investigation Date):					
Event ID (Investigation Name):	SI	DI	SI/DI	ABS	ERS
Field Logbook Number:					
Logbook Page Numbers:					
Surveyors (Investigation Team Members):					
Field Form Check (100% of forms):					

Occupant Information		
Is there any knowledge of former vermiculite miners, close relatives of vermiculite miners, or any highly exposed persons living at or visiting the property?	Yes	No
Is the resident, past or present, diagnosed with an asbestos-related disease?	Yes	No
	N/A	
Number of adult residents or employees?		
Number of child residents?		
Age range of child residents?	0 - 6	7 - 12
	13 - 18	N/A
Does the current resident have any outdoor pets?	Yes	No
	N/A	
If wood chips are present on the property, what is the source?		
Has the current resident purchased vermiculite or vermiculite containing soil from a commercial source (eg ACE, Home Depot). If yes, note known locations in comments field	Yes	No
Comments		

LIBBY ASBESTOS SITE
Interior Property Inspection Form (IPIF)

General Information					
Address:					
Property ID:					
Location ID:					
Location Type:					
Location Description:					
Survey Date (Investigation Date):					
Event ID (Investigation Name):	SI	DI	SI/DI	ABS	ERS
Field Logbook Number:					
Logbook Page Numbers:					
Surveyors (Investigation Team Members):					
Field Form Check (100% of forms):					
Screening Field Check (2% of forms):					

*Circle all that apply

Building Attributes		
Year of construction		
Heating source	Wood/Coal Electric	Propane/Oil None
Heat distribution	Forced Air N/A	Radiant
Cooling system	Air Conditioner None	Swamp Cooler

Attic Attributes		
Type of Attic	Finished Combined	Unfinished N/A
Are there any entryway, porch, walkway awnings, or other additions that share airspace with the main attic or each other?	Yes N/A	No
Are there any entryway, porch, walkway awnings, or other additions that do not share airspace with the main attic or each other?	Yes N/A	No
Are there kneewalls present? (finished attics only)	Yes N/A	No
Is there flooring in the attic (above joist)?	Yes N/A	No
Are there any drop ceilings below the attic?	Yes N/A	No
Are there any physical/structural issues, damages, or concerns?	Yes (note on sketch) N/A	No
Type of hazards near the attic access? (note on sketch)	Electrical None	Limited/Blocked access

Attic Inspection		
Vermiculite in attic?	Yes N/A	No
Vermiculite in attic-above-attic? (finished attics only)	Yes N/A	No
Vermiculite under floor?	Yes N/A	No
Vermiculite on drop ceiling?	Yes N/A	No
Vermiculite behind kneewalls? (finished attics only)	Yes N/A	No

Living Space Assessment		
Is vermiculite leaking into any living spaces?	Yes (note on sketch) N/A	No
Is vermiculite exposed in any cracks, holes, fixtures, etc.?	Yes (note on sketch) N/A	No
Is vermiculite exposed in any closets or cabinets?	Yes (note on sketch) N/A	No
Vermiculite present in interior walls	Yes N/A	No
Vermiculite present in exterior walls	Yes N/A	No
Understructure Attributes and Inspection		
Type of Understructure	Basement Cellar	Crawlspace None
Type of flooring in understructure	Concrete Finished Flooring N/A	Wood Soil
Are any areas of the understructure inaccessible?	Yes (note on sketch) N/A	No
Are any areas of the understructure frequently accessed?	Yes (note on sketch) N/A	No
Vermiculite in understructure?	Yes N/A	No
Is vermiculite leaking into the understructure from above?	Yes (note on sketch) N/A	No

LIBBY ASBESTOS SITE
Interior Property Inspection Form (IPIF)

Bulk/Building Materials		
Evidence of vermiculite additives used in building materials?	Yes	No
Location of building materials containg vermiculite	Ground Floor Third Floor Understructure	Second Floor Attic N/A
Are any vermiculite containing building materials friable?	Yes (note on sketch and collect sample) N/A	No

Additional Information		
Is there any knowledge of the interior ever having vermiculite insulation?	Yes N/A	No

Comments

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APPENDIX D
Analytical Requirements Summary Sheet (OU4GI0410-Rev2)

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SAP ANALYTICAL SUMMARY # __OU4GI0410_
SUMMARY OF PREPARATION AND ANALYTICAL REQUIREMENTS FOR ASBESTOS

Title: Final Sampling and Analysis Plan/Quality Assurance Project Plan for General Property Investigations, Revision 2, OU4, Libby Asbestos Site

Date/Revision: April 15, 2013 (Revision 2)

EPA Technical Advisor: Liz Fagen (303-312-6095, Fagen.Elizabeth@epamail.epa.gov)
(contact to advise on DQOs of SAP related to preparation/analytical requirements)

Sampling Program Overview: The objectives of the general property investigation (GPI) sampling program are two-fold: 1) perform screening investigations (SIs) at OU4 properties to identify sources of Libby amphibole asbestos (LA); and 2) based on SI findings, perform detailed investigations (DIs) at the properties to determine the extent of LA removal required at properties. SI consists of a verbal interview with property owners, visually inspecting each property for potential sources of LA indoors and outdoors, and collecting 30-point composite surface soil samples. DIs consists of inspecting, in detail, indoor and outdoor areas and collecting 30-point composite surface soil samples.

Sample ID Prefix: 2S- for SI samples and 2D- for DI samples ***(effective 04/23/10-04/15/12)***
3G- ***(effective 04/16/12)***
4G- ***(effective 04/15/13)***

PLM Preparation and Analytical Requirements:

Medium Code	Sample Type	Preparation Method	Analysis Method	Applicable Laboratory Modifications
A	Soil – all field samples and field duplicate samples	ISSI-LIBBY-01 Rev. 11	PLM-Grav: SRC-LIBBY-01 Rev. 3 PLM-VE: SRC-LIBBY-03 Rev. 3	N/A

Laboratory Quality Control Sample Frequencies:
PLM: Lab Duplicates – 10% (cross-check 8%; self-check 2%)
Inter-laboratory – 1% *(to be selected post hoc by QATS contractor)*

Requirements Revision:

Revision #:	Effective Date:	Revision Description
0	4/23/2010	N/A
1	4/16/2012	• Sample ID prefix change from 2S- / 2D- to 3G- to correspond to GPI SAP revision • Bulk samples will no longer be collected or analyzed
2	4/15/2013	• Update title of guidance document (Revision 2) • Sample ID prefix change from 3G- to 4G- to correspond to GPI SAP/QAPP revision

Analytical Laboratory Review Sign-off:

All laboratories signed the original version of this analytical summary sheet (Revision 0); this revision (Revision 2) did not require another signature process.

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